SAR EVALUATION REPORT

FCC 47 CFR § 2.1093

For
Portable Bluetooth Speaker

FCC ID: APIJBLCHARGE4Q
Model Name: CHARGE4Q

Report Number: 4788930407-SAR-2
Issue Date: March 14, 2019

Prepared for
Harman International Industries, Inc.
8500 Balboa Boulevard, Northridge, CA 91329, UNITED STATES

Prepared by
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Revision History

Rev.	Date	Revisions	Revised By
V1.0	March 14, 2019	Initial Issue	\

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1. Attestation of Test Results

Applicant Name	Harman International Industries, Inc.	
Address	8500 Balboa Boulevard, Northridge, CA 91329, UNITED STATES	
Manufacturer	Harman International Industries, Inc.	
Address	8500 Balboa Boulevard, Northridge, CA 91329, UNITED STATES	
EUT Name	Portable Bluetooth Speaker	
Model Name	CHARGE4Q	
Sample Status	Normal	
Brand	JBL	
Sample Received Date	March 11, 2019	
Date of Tested	March 14, 2019	
Applicable Standards	FCC 47 CFR § 2.1093 KDB publication	
SAR Limits (W/Kg)		
Exposure Category	Peak spatial-average(1g of tissue)	Extremities (hands, wrists, ankles, etc.) (10g of tissue)
General population / Uncontrolled exposure	1.6	4
The Highest Reported SAR (W/kg)		
RF Exposure Conditions	**Equipment Class**	
	DSS (BT)	
Body (1-g)	1.110	
Test Results	Pass	
Tested By: James Qin Engineer Project Associate	Reviewed By: Shawn Wen Laboratory Leader	Approved By: Stephen Guo Laboratory Manager

2. Test Specification, Methods and Procedures

The following FCC Published RF exposure KDB procedures:

- o 447498 D01 General RF Exposure Guidance
- o 690783 D01 SAR Listings on Grants
- o 865664 D01 SAR measurement 100 MHz to 6 GHz
- o 865664 D02 RF Exposure Reporting

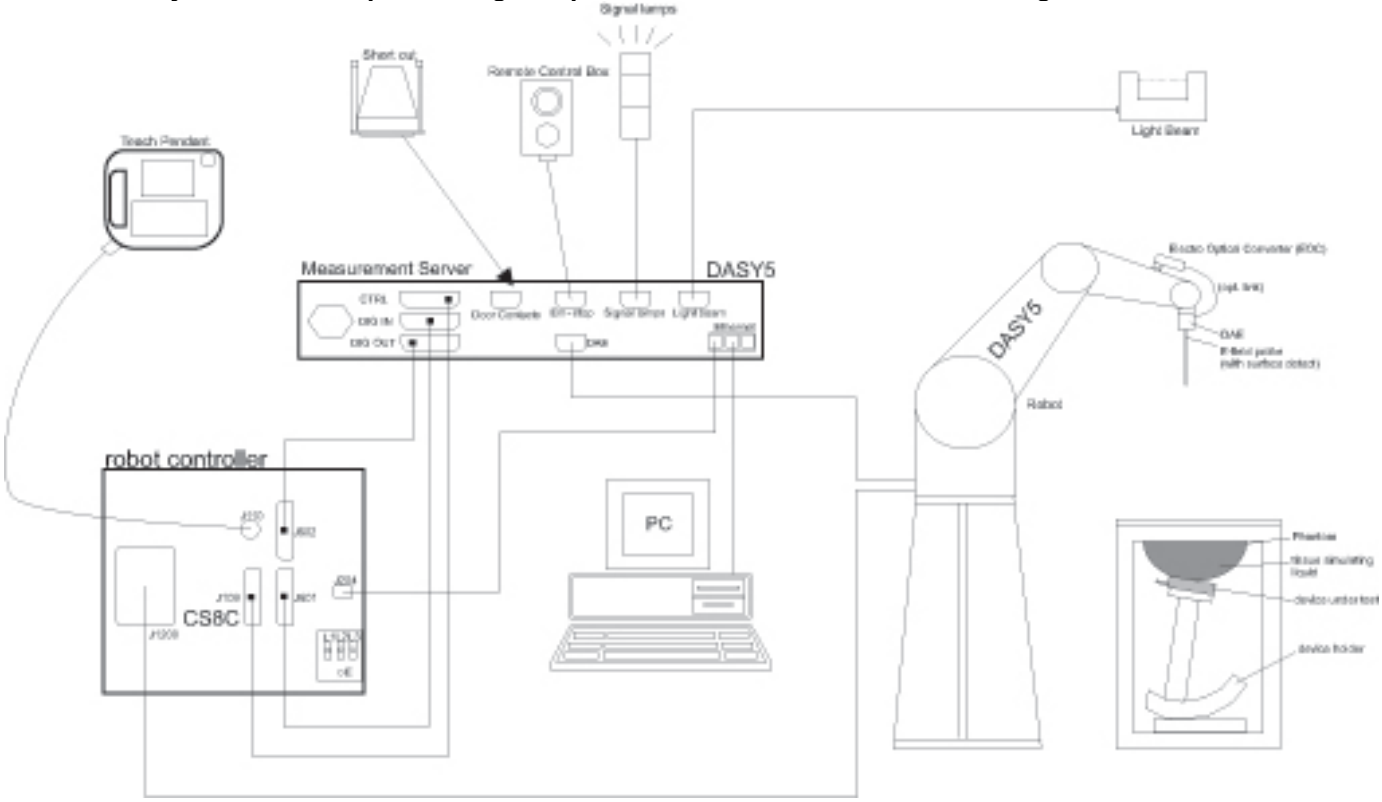
3. Facilities and Accreditation

Test Location	UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch.
Address	Building 10, Innovation Technology Park, Song Shan Lake Hi tech Development Zone, Dongguan, 523808, China
Accreditation Certificate	**A2LA (Certificate No.: 4102.01)** UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch has been assessed and proved to be in compliance with A2LA. **FCC (FCC Recognized No.: CN1187)** UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch has been recognized to perform compliance testing on equipment subject to the Commission's Declaration of Conformity (DoC) and Certification rules **IC(Company No.: 21320)** UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch has been registered and fully described in a report filed with Industry Canada. The Company Number is 21320. **VCCI (Registration No.: G-20019, R-20004, C-20012 and T-20011)** UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch has been assessed and proved to be in compliance with VCCI, the Membership No. is 3793. Facility Name: Chamber D, the VCCI registration No. is G-20019 and R-20004 Shielding Room B , the VCCI registration No. is C-20012 and T-20011
Description	All measurement facilities use to collect the measurement data are located at Building 10, Innovation Technology Park, Song Shan Lake Hi tech Development Zone, Dongguan, 523808, China

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 Win7 and the DASY52 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 v01r04 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 v01r04 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·$\Delta z_{Zoom}(n-1)$	
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.

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 greater 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.

	Name of equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
☒	ENA Network Analyzer	Keysight	E5080A	MY55100583	December 10, 2019
☒	Dielectric Assessment Kit	SPEAG	SM DAK 040 SA	1155	NCR
☒	DC power supply	Keysight	E36103A	MY55350020	December 10, 2019
☒	Signal Generator	Rohde & Schwarz	SME06	837633\001	December 10, 2019
☒	BI-Directional Coupler	WERLATONE	C8060-102	3423	December 10, 2019
☒	Peak and Average Power Sensor	Keysight	E9323A	MY55440013	December 10, 2019
☒	Peak and Average Power Sensor	Keysight	E9323A	MY55420006	December 10, 2019
☒	Dual Channel PK Power Meter	Keysight	N1912A	MY55416024	December 10, 2019
☒	Amplifier	CORAD TECHNOLOGY LTD	AMF-4D-00400600-50-30P	1983561	NCR
□	Base Station Simulator	Rohde & Schwarz	CMW500	155523	December 10, 2019
☒	Dosimetric E-Field Probe	SPEAG	EX3DV4	7383	December 19, 2019
☒	Data Acquisition Electronic	SPEAG	DAE3	427	December 11, 2019
□	Dipole Kit 750 MHz	SPEAG	D750V3	1153	December 6, 2021
□	Dipole Kit 835 MHz	SPEAG	D835V2	4d206	December 5, 2021
□	Dipole Kit 900 MHz	SPEAG	D900V2	1d190	December 5, 2021
□	Dipole Kit 1800 MHz	SPEAG	D1800V2	2d212	December 6, 2021
□	Dipole Kit 1900 MHz	SPEAG	D1900V2	5d212	December 7, 2021
□	Dipole Kit 2300 MHz	SPEAG	D2300V2	1065	December 4, 2021
☒	Dipole Kit 2450 MHz	SPEAG	D2450V2	977	December 4, 2021
□	Dipole Kit 2600 MHz	SPEAG	D2600V2	1117	December 7, 2021
☒	Dipole Kit 5 GHz	SPEAG	D5GHzV2	1231	December 14, 2021
☒	Software	SPEAG	DASY52	N/A	NCR
☒	Twin Phantom	SPEAG	SAM V5.0	1805	NCR
□	ELI Phantom	SPEAG	ELI V5.0	1235	NCR
☒	Thermometer	Control Company	4242	150709653	December 6, 2019
☒	Hygrometer	\	GX-138	\	September 5, 2019

Note:

1) As per KDB865664D01 requirements for dipole calibration, the test laboratory has adopted three-year extended calibration interval. Each measured dipole is expected to evaluate with the following criteria at least on annual interval in Appendix C.
   a) There is no physical damage on the dipole;
   b) System check with specific dipole is within 10% of calibrated value;
   c) The most recent return-loss result, measured at least annually, deviates by no more than 20% from the previous measurement.
   d) The most recent measurement of the real or imaginary parts of the impedance, measured at least annually is within 5Ω from the previous measurement.
2) Dielectric assessment kit is calibrated against air, distilled water and a shorting block performed before measuring liquid parameters.
3) NCR is short for “No Calibration Requirement”.

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. The equivalent ratio (1.5/1.6) is applied to extremity and occupational exposure conditions.

6. Device Under Test (DUT) Information

6.1. DUT Description

The EUT is a portable wireless speaker with BT radio.	
Device Dimension	Overall (Length x Width x Height): 220 mm x 85 mm x 95 mm
Accessory	None

6.2. Wireless Technology

Wireless technology	Frequency band
BT	2.4 GHz

7. SAR Test Configuration

The EUT is a small size portable device, and it may extreme close to the human body when used, so 1-g Body SAR (0mm) evaluation is considered.

8. Conducted Output Power Measurement

8.1. BT (Average power)

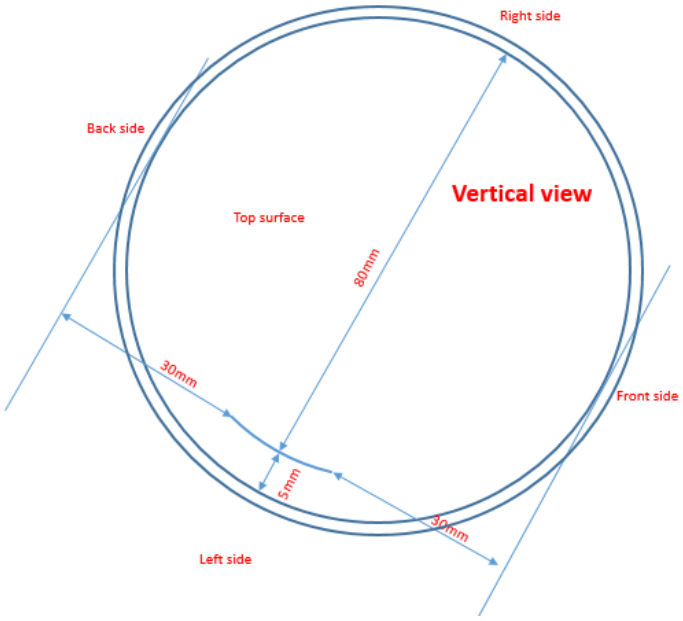
BT 2450	Average Conducted Power (dBm)			Duty cycle (%)
	0CH	39CH	78CH	
DH5	15.46	16.22	16.26	77
2DH5	12.53	13.35	13.57	\
3DH5	12.50	13.26	13.64	\

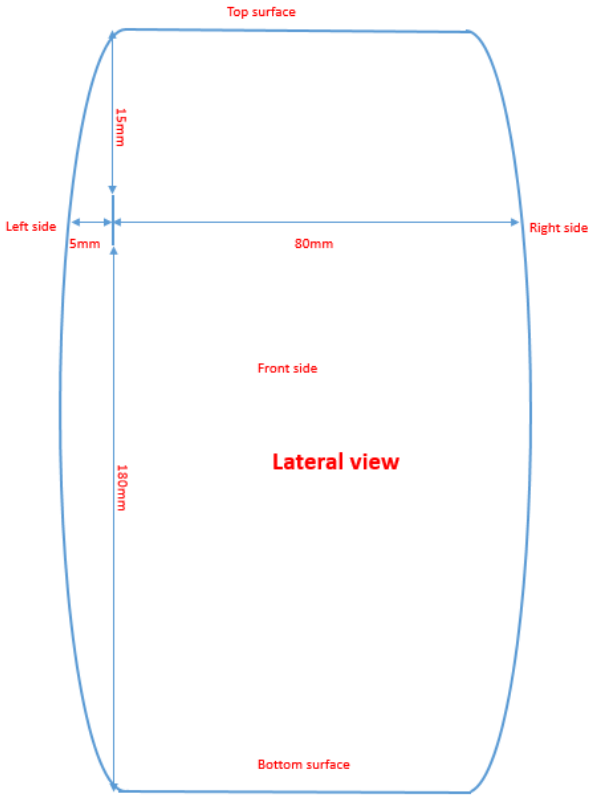
BT 2450	Average Conducted Power (dBm)			Duty cycle (%)
	0CH	39CH	78CH	
BLE	5.15	5.80	5.96	\

Note:
1) The mode with the highest tune-up tolerance is selected to perform SAR evaluation.

9. RF Exposure Conditions

Refer to the diagram of the device which attached below for the specific details of the antenna to outer surface distances.





Per FCC KDB 447498D01:

1. The 1-g SAR 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 product specific 10-g 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

When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

2. The SAR exclusion threshold for distances >50mm is defined by the following equation, as illustrated in KDB 447498 D01 Appendix B:

a) at 100 MHz to 1500 MHz

[Power allowed at numeric threshold for 50 mm in step 1) + (test separation distance - 50 mm)·(f(MHz)/150)] mW

b) at > 1500 MHz and ≤ 6 GHz

[Power allowed at numeric Threshold at 50 mm in step 1) + (test separation distance - 50 mm)·10] mW

For 1-g SAR (antenna to outer surface separation distance less than 50mm)

Position	Frequency (MHz)	Power (dBm)	Power (mW)	Separation Distance (mm)	Calculation Result	Threshold	SAR Test
Top surface	2480	16.50	44.67	15	4.7	3.0	Required
Left side	2480	16.50	44.67	5	14.1	3.0	Required
Front side	2480	16.50	44.67	30	2.3	3.0	Excluded
Bottom side	2480	16.50	44.67	30	2.3	3.0	Excluded

Note:

1) If the calculated result is greater than the threshold, SAR evaluation for the corresponding position is required. If not, SAR evaluation for the corresponding position is not required.

For 1-g SAR (antenna to outer surface separation distance greater than 50mm)

Position	Frequency (MHz)	Power (dBm)	Power (mW)	Power allowed at 50mm	Separation Distance (mm)	Calculation Result (mW)	SAR Test
Bottom surface	2480	16.50	44.67	95.25	180.00	2244.58	Excluded
Front side	2480	16.50	44.67	95.25	80.00	591.25	Excluded

Note:

1) If the power in mW is greater than the calculated result, SAR evaluation for the corresponding position is required. If not, SAR evaluation for the corresponding position is not required.

10. Dielectric Property Measurements & System Check

10.1. 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 v01r04 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

IEEE Std 1528-2013
Refer to Table 3 within the IEEE Std 1528-2013

Dielectric Property Measurements Results:

Liquid	Freq.	Liquid Parameters				Delta(%)		Limit (%)	Temp. (℃)	Test Date
		Measured		Target						
		ϵ_r	σ	ϵ_r	σ	ϵ_r	σ			
Body 2450	2360	51.71	1.87	52.82	1.86	-2.10	0.65	±5	23	March 14, 2019
	2450	51.46	1.96	52.70	1.95	-2.35	0.72	±5		
	2540	51.15	2.07	52.59	2.08	-2.74	-0.48	±5		

10.2. 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 10mm (above 1GHZ) and 15mm (below 1GHz) from dipole center to the simulating liquid surface.
- For area scan, standard grid spacing for head measurements is 15 mm in x- and y- dimension(≤2GHz), 12 mm in x- and y-dimension(2-4 GHz) and 10mm in x- and y- dimension(4-6GHz).
- For zoom scan, Δx_{zoom}, Δy_{zoom}≤ 2GHz - ≤8mm, 2-4GHz - ≤5 mm and 4-6 GHz-≤4mm; Δz_{zoom} ≤3GHz - ≤5 mm, 3-4 GHz- ≤4mm and 4-6GHz-≤2mm.
- Distance between probe sensors and phantom surface was set to 3 mm except for 5 GHz band. For 5GHz band, Distance between probe sensors and phantom surface was set to 2.5 mm
- The dipole input power (forward power) was set to 100 mW or 250 mW depend on the certificate of the dipoles.
- The results are normalized to 1 W input power.

System Check Results

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

System Dipole Serial #	T.S. Liquid		Measured Results Zoom Scan (W/Kg)	Measured Results Normalize to 1W (W/Kg)	Target (Ref. value)	Delta (%)	Limit (%)	Temp. (℃)	Test Date
977	Body 2450	1g	12.200	48.80	51.60	-5.43	±10	23	March 14, 2019
		10g	5.580	22.32	24.10	-7.39			

11. Measured and Reported (Scaled) SAR Results

As per KDB 447498 sec.4.1.e), When SAR or MPE is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as reported.

Scaled SAR calculation formula:
Scaled SAR = Tune-up in mW / Conducted power in mW * Duty cycle (if available) * SAR value

SAR Test Reduction criteria are as follows:

KDB 447498 D01 General RF Exposure Guidance:
A）Per KDB447498 D01 v06, all SAR measurement results are scaled to the maximum tune-up tolerance limit to demonstrate SAR compliance.
B）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.

Per KDB865664 D01 v01r04:

For each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/Kg; if the deviation among the repeated measurement is ≤ 20%, and the measured SAR <1.45W/Kg, only one repeated measurement is required.

11.1. SAR Test Results of BT

Test Positon (Body 0mm)	Test Mode	Channel/ Frequency	Power (dBm)		SAR Value	Power Drift	Duty Factor (%)	Scaled (W/Kg)
			Tune-up	Meas.	1g (Zoom Scan)			
Left side	DH5	39/2441	16.50	16.22	0.801	0.12	77.00	1.110
Top surface	DH5	39/2441	16.50	16.22	0.139	0.17	77.00	0.193
Left side	DH5	0/2402	15.50	15.46	0.802	-0.11	77.00	1.051
Left side-repeated	DH5	0/2402	15.50	15.46	0.844	0.18	77.00	1.106
Left side	DH5	78/2480	16.50	16.26	0.589	0.10	77.00	0.808

12. Simultaneous Transmission SAR Analysis

There is only one antenna assembled, so simultaneous transmission doesn't exist.

Appendixes

Refer to separated files for the following appendixes.

20190311-SAR-2_App A Photo

20190311-SAR-2_App B System Check Plot

20190311-SAR-2_App C Highest Test Plot

20190311-SAR-2_App D Cal. Certificates

---------End of Report----------