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SAR Report

EUT Name: FreeStyle Precision Pro

EUT Model: FreeStyle Precision Pro

FCC ID: QXS-FPP01

IC ID: 12106A-FPP01

Prepared for:

Abbott Diabetes Care, Inc
1360 South Loop Road
Alameda, CA 94502
USA

Prepared by:

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Report/Issue Date: October 9, 2019

Report Number: 31854839.001

Job Number: 160430

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APPENDIX A: PLOTS

APPENDIX B: PHOTOS

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Statement of Compliance

Manufacturer: Abbott Diabetes Care, Inc
1360 South Loop Road
Alameda, CA 94502
USA
Name of Equipment: FreeStyle Precision Pro
Model Number: FreeStyle Precision Pro
FCC ID: QXS-FPP01
IC ID: 12106A-FPP01
Test Dates: November 12, 2018, April 9-11, 2019

Guidance Documents:

FCC Code of Federal Regulations Title 47, Various FCC KDBs

RSS-102, Safety Code 6, Various FCC KDBs

Test Methods:

IEEE 1528-2013, Various FCC KDBs

IEEE 1528-2013, IEC 62209-1:2005, IEC 62209-2:2010, Various FCC KDBs

The RF exposure test and documented data described in this report has been performed and recorded by TÜV Rheinland, in accordance with the standards and procedures listed herein. As the responsible authorized agent of the EMC laboratory, I hereby declare that the equipment described above has been shown to be compliant with the RF exposure requirements of the stated regulations and standards based on these results. If any special accessories and/or modifications were required for compliance, they are listed in this report.

This report must not be used to claim product endorsement by A2LA or any agency of the U.S. Government. This report shall not be reproduced except in full, without the written authorization of TÜV Rheinland of North America.

Josie Sabado
Test Engineer

October 9, 2019
Date

Arndt Stoecker
Laboratory Signatory

October 9, 2019
Date



Test Cert. # 3331.02

1 Executive Summary

1.1 Scope

This report is intended to document the status of conformance with the applicable RF exposure requirements based on the results of testing performed on November 12, 2018 and April 9-11, 2019 on the FreeStyle Precision Pro model FreeStyle Precision Pro manufactured by Abbott Diabetes Care, Inc. This report only applies to the specific samples tested under the stated test conditions. It is the responsibility of the manufacturer to assure that production units of this model are manufactured with identical or equivalent electrical and mechanical components. This report is further intended to document changes and modifications to the EUT throughout its life cycle. All documentation will be included as a supplement.

1.2 Purpose

Testing was performed to evaluate the SAR levels of the EUT in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report.

1.3 Summary of Test Results

Equipment Class	Exposure Condition	Maximum Reported 1g SAR (W/kg)	Result
DTS	UMPC	1.10	Complies
NII	UMPC	0.420	Complies

Notes: UMPC = Ultra Mobile Portable Computer

1.4 Equipment Modifications

No modifications were found to be necessary in order to achieve compliance.

1.5 Deviations from the Specifications

None

2 Laboratory Information

2.1 Accreditations & Endorsements

2.1.1 NIST / A2LA



TUV Rheinland of North America is accredited by the National Voluntary Laboratory Accreditation Program, which is administered under the auspices of the National Institute of Standards and Technology. The laboratory has been assessed and accredited in accordance with ISO Guide 17025:2017. The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated every 2 years.

2.1.2 US Federal Communications Commission



TUV Rheinland of North America at 5015 Brandin Court, Fremont, CA 94538, is accredited by the commission for performing testing services for the general public on a fee basis. These laboratory test facilities have been fully described in reports submitted to and accepted by the FCC. The laboratory scope of accreditation includes: Title 47 CFR Parts 15, 18, 22, 24, 27, and 90. The accreditation is updated every 2 years.

2.1.3 Canada – Industry Canada



TUV Rheinland of North America at the 5015 Brandin Court, Fremont, CA 94538 address is accredited by Industry Canada for performing testing services for the general public on a fee basis. This laboratory test facility has been fully described in reports submitted to and accepted by Industry Canada (File Number 2932D). The accreditation is updated every 3 years.

2.1.4 Acceptance by Mutual Recognition Arrangement



The United States has an established agreement with specific countries under the Asia Pacific Laboratory Accreditation Corporation (APLAC) Mutual Recognition Arrangement. Under this agreement, all TUV Rheinland at 5015 Brandin Court, Fremont, CA 94538 test results and test reports within the scope of the laboratory NIST / A2LA accreditation will be accepted by each member country.

2.2 Test Facilities

All of the test facilities are located at 1279 Quarry Lane, Ste. A, Pleasanton, California 94566, USA. The 5015 Brandin Court, Fremont, CA 94538, USA location is considered a Pleasanton annex.

3 Product Information

3.1 Product Description

Blood glucose and beta-Ketone monitoring meter

3.2 Equipment Under Test (EUT)

EUT Specification	
EUT Dimensions	199.4 x 74.77 x 48.6 mm
Power Input	3 VDC via 2xAA batteries
Exposure Type	<input checked="" type="checkbox"/> General Population / Uncontrolled <input type="checkbox"/> Occupational / Controlled
Exposure Condition	<input type="checkbox"/> Next to the Ear <input type="checkbox"/> Head Worn <input type="checkbox"/> Body Worn <input checked="" type="checkbox"/> Next to the Body <input checked="" type="checkbox"/> Handheld <input checked="" type="checkbox"/> Ultra Mobile Portable Computer
Hardware Version	PRT19550-230
Software Version	1.7.2 (Redpine module Firmware)
Power Reduction Modes	None

3.3 Air Interfaces

Air Interface	Supported Capabilities	Modulation	Maximum Duty Cycle	Band	Frequency Range (MHz)	Maximum Output Power Including Tolerance (dBm)
WLAN: 802.11 b/g	• b/g/n mode	• BPSK • QPSK • 16QAM • 64QAM	100%	N/A	2400 – 2483.5	20
WLAN: 802.11 a	• a/n mode	• QPSK • 16QAM • 64QAM	100%	UNII-1	5150 – 5250	12
				UNII-2A	5250 – 5350	12
				UNII-2C	5470 – 5725	12
				UNII-3	5725 – 5825	12

3.4 Antenna Information

Antenna	Internal / External	Antenna Type	Frequency Range (MHz)	Antenna Gain (dBi)
802.11 a/b/g/n	Internal	PCB	2400 – 2483.5	1.8
			5000 – 6000	3

3.5 Simultaneous Transmission Configurations

The EUT contains one radio module and one antenna. There are no simultaneous transmission configurations.

3.6 Equipment Configuration

Proprietary test software was used to set the radio to transmit continuously with 100% duty cycle. The test software was used to set the channel, power, data rate, and modulation.

3.7 Description of Sample used for Testing

Device	Serial Number	Configuration	Used For
EUT	KFDAY158-A0160	Radiated and Conducted	2.4 GHz 802.11 b/g/n
EUT	KFDAY158-A0119	Radiated and Conducted	5 GHz 802.11a/n, UNII-1, UNII-3 bands
EUT	KFAY158-A0120	Conducted	5 GHz 802.11a/n, UNII-2A, UNII-2C bands
EUT	KFAY158-A0025	Radiated	5 GHz 802.11a/n, UNII-2A, UNII-2C bands

3.8 Description of Sample Accessories used for Testing

No accessories were used for testing.

3.9 Support Equipment used for Testing

No support equipment was used during testing.

4 SAR Measurement Information

4.1 Test Specifications

The following specifications were used during the course of testing and are referenced in this test report.

Specification Number	Title	Version
IEEE 1528	IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques	2013
FCC KDB 447498, D01	RF Exposure Procedures and Equipment Authorization Policies for Mobile and Portable Devices	v06
FCC KDB 865664, D01	SAR Measurement Requirements for 100 MHz to 6 GHz	v01r04
FCC KDB 248227, D01	SAR Guidance for IEEE 802.11 (Wi-Fi) Transmitters	v02r02
FCC KDB 941225, D07	SAR Evaluation Procedures for UMPC Mini-Tablet Devices	v01r02
RSS-102	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)	Issue 5 March 2015
IEC 62209-2	Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures – Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)	Ed. 1.0 2010

4.2 SAR Limit

The following SAR limits have been applied in this test report to evaluate the compliance of the EUT against regulatory requirements.

Reference	Exposure Condition	Limit (W/kg)	Average Mass (g)
FCC §1.1310 & §2.1093	Head and Trunk	1.6	1
RSS-102 Safety Code 6	Head, Neck, and Trunk	1.6	1

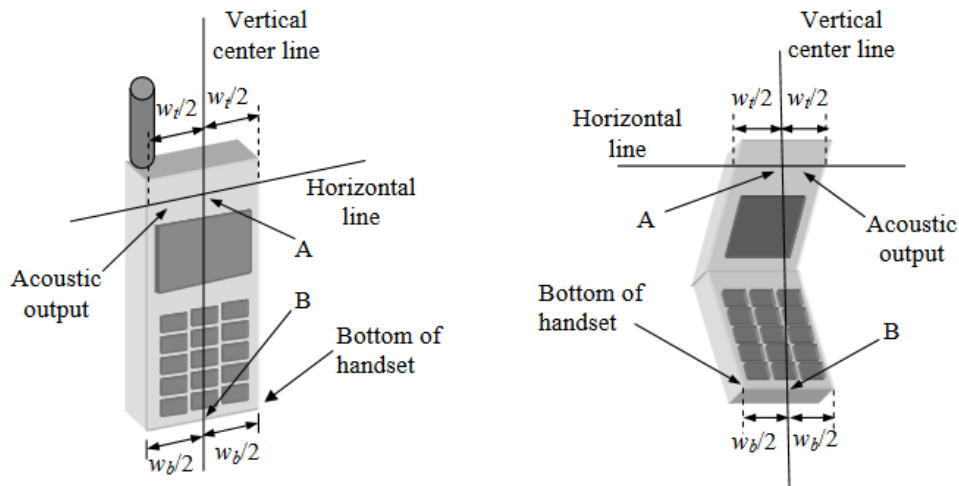
4.3 Environmental Conditions

The ambient and liquid temperature is measured throughout the course of SAR measurements and is maintained between 18 °C to 25 °C. The temperature drift of the liquid is ≤ 2 °C

4.4 Device Test Positions

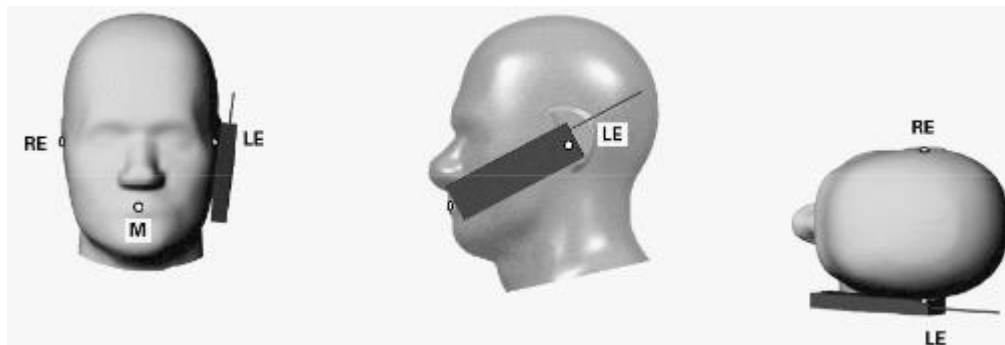
Head Positions

Reference lines are drawn on the handset to accurately position the handset against the SAM phantom. The vertical center line bisects the width of the handset into two equal halves. The horizontal line is perpendicular to the vertical center line and passes through the center of the acoustic output. The intersection point of the vertical center line and the horizontal line is the ear reference point. The following figure illustrates the position of the vertical center line and the horizontal line.

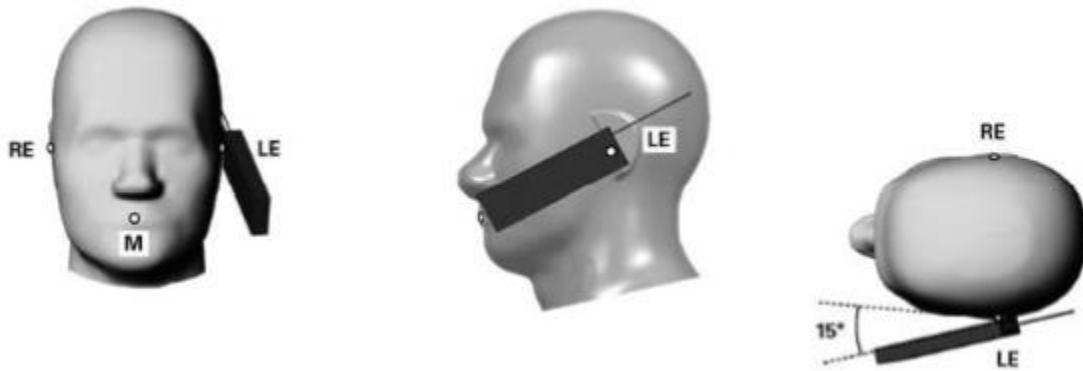


There are four head positions: right touch, right tilt, left touch, and left tilt. Left and right indicate the side of the head.

In touch positions the handset makes contact with the head at two points. The first contact point is where the ear reference point of the handset makes contact with the ear pinna of the SAM phantom. The second contact point is where the handset makes contact with the cheek of the SAM phantom. The following figure is an example of the left touch position.



In tilt positions the handset is tilted at a 15° angle from the ear. The top edge of the handset makes contact with the SAM phantom. The ear reference point of the handset is centered on the ear pinna of the SAM phantom. The following figure is an example of the left tilt position.



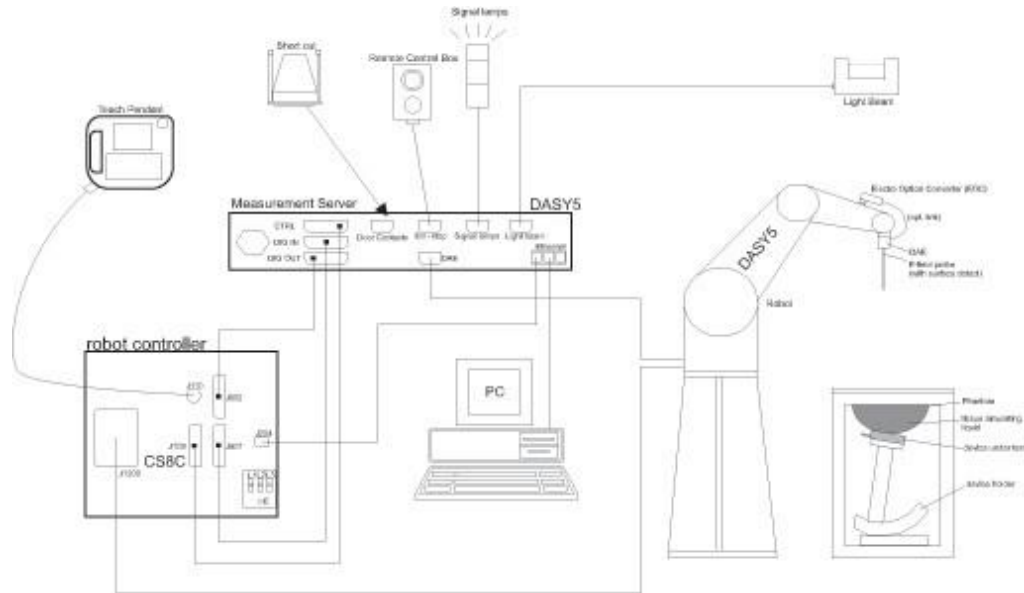
Body Positions

Body SAR measurements are done for the surfaces of the EUT that would face the user during normal operation. The center of the EUT surface is centered on the surface of the flat phantom. If applicable, a separation distance specified by the manufacturer is used between the EUT and the phantom.

For EUTs that do not fit completely within the measurement area of the phantom, pretest measurements are done to find the hot spot. Once the hot spot is found, the EUT is placed so that the hot spot is at the center of the flat phantom.

4.5 SPEAG DASY5 Measurement System

4.5.1 System Overview



The SPEAG DASY5 measurement system consists of the following items:

- A standard high precision 6-axis robot (Stäubli TX/RX family) 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 professional operating system and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

4.5.2 Robot

The Stäubli TX60L robot is a high precision, high reliability industrial robot. The placement precision repeatability is within ± 0.02 mm. It uses a brushless synchronous motor with low ELF interference. The robot is controlled by the Stäubli CS8c robot controller.

4.5.3 Data Acquisition Electronics

The data acquisition electronics consist of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder with a control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock.

The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

The input impedance of both the DAE4 as well as of the DAE3 box is 200M Ω ; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

4.5.4 Probe

The EX3DV4 dosimetric SAR probe are specially designed and calibrated for use in liquids with high permittivities. The enclosure of the probe is made of PEEK material. The probe is calibrated by SPEAG according to ISO/IEC 17025. See the appendix for the probe calibration report including specifications of probe parameters.

4.5.5 Phantoms

The SAM twin phantom is a fiberglass shell phantom with $2\text{ mm} \pm 0.2\text{ mm}$ shell thickness (except the ear region, where shell thickness increases to $6\text{ mm} \pm 0.2\text{ mm}$). The phantom has three measurement areas:

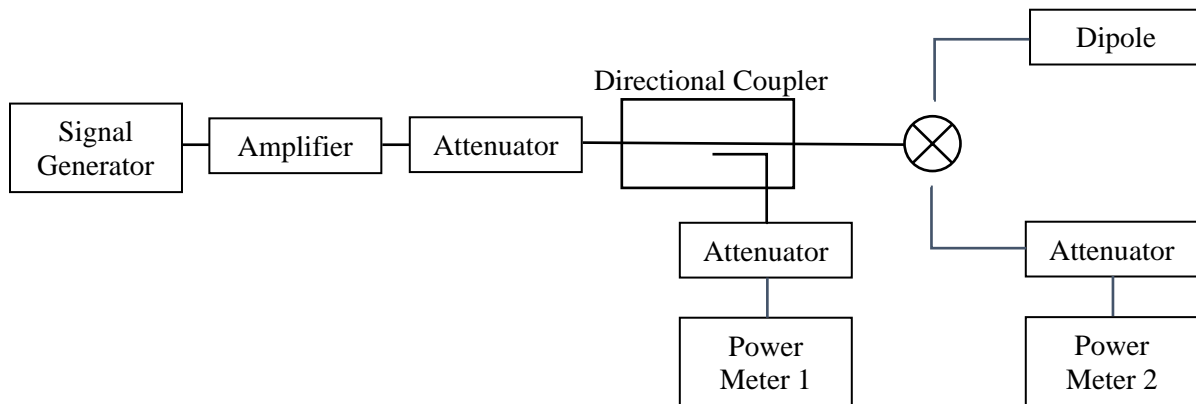
- Left hand
- Right hand
- Flat phantom

The shape of the left hand and right hand phantoms are according to IEEE 1528 and IEC 62209-1. The relative permittivity of the shell is 3.5 ± 0.5 . The loss tangent is ≤ 0.05 .

The ELI phantom is intended for compliance testing of handheld and body-mounted wireless devices. It is fully compatible with IEC 62209-2. The flat bottom surface is an elliptical shape measuring 600 mm in length and 400 mm in width. The shell thickness is $2\text{ mm} \pm 0.2\text{ mm}$. The relative permittivity is 4 ± 1 and the loss tangent is ≤ 0.05 .

4.5.6 System Check Procedure

The purpose of the system check is to verify that a specific SAR measurement system operates within its specifications at the device test frequencies. It is done within 24 hours before SAR measurements. The setup for system check is as follows



1. An unmodulated continuous wave signal is generated at the frequency to be tested.
2. The power at the input to the dipole is measured using power meter 2 while the forward power at the directional coupler is measured using power meter 1. The output power of the signal generator is varied until 20 dBm is measured at power meter 2.
3. Power meter 2 is disconnected and the dipole is connected. The output power of the signal generator is varied until power meter 1 measures the same forward power as when 20 dBm was measured with power meter 2.
4. A SAR measurement is performed using the dipole with the same area scan and zoom scan parameters required for a SAR measurement on the EUT.
5. The 1g and 10g SAR result is compared to the 1g and 10g SAR value in the dipole's calibration certificate.

4.5.7 SAR Measurement Procedure

Power Reference Measurement

A single point SAR measurement is measured above the center of the radiating structure. This power reference measurement is compared to the power drift measurement after the zoom scan to ensure the output power of the EUT does not drift during the SAR measurement.

Area Scan

The area scan is done in the x-y plane. The measurement grid is larger than the area of the EUT surface under test with the following characteristics:

	$\leq 3 \text{ GHz}$	$> 3 \text{ GHz}$
Maximum distance from the closest measurement point (geometric center of probe sensors) to phantom surface	5 mm \pm 1 mm	$\delta \cdot \ln(2)/2 \text{ mm} \pm 0.5 \text{ mm}$
Maximum probe angle from probe axis to phantom surface normal at the measurement location	$30^\circ \pm 1^\circ$	$20^\circ \pm 1^\circ$
Maximum area scan spatial resolution: $\Delta x_{\text{Area}}, \Delta y_{\text{Area}}$	$\leq 2 \text{ GHz}: \leq 15\text{mm}$ $2 - 3 \text{ GHz}: \leq 12 \text{ mm}$	$3 - 4 \text{ GHz}: \leq 12 \text{ mm}$ $4 - 6 \text{ GHz}: \leq 10 \text{ mm}$
	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 \leq the corresponding x or y dimension of the test device with at least one measurement point on the test device.	
Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium.		

Zoom Scan

Once the hot spot is found in the area scan, a zoom scan measurement is done above the hot spot. A uniform measurement grid is done in the x, y, and z direction in the form of a cube. The following characteristics are used:

	$\leq 3 \text{ GHz}$	$> 3 \text{ GHz}$
Maximum zoom scan spatial resolution: $\Delta x_{\text{zoom}}, \Delta y_{\text{zoom}}$	$\leq 2 \text{ GHz}: \leq 8 \text{ mm}$ $2 - 3 \text{ GHz}: \leq 5 \text{ mm}$	$3 - 4 \text{ GHz}: \leq 5 \text{ mm}$ $4 - 6 \text{ GHz}: \leq 4 \text{ mm}$
Maximum zoom scan spatial resolution, normal to phantom surface: Δz_{zoom}	$\leq 5 \text{ mm}$	$3 - 4 \text{ GHz}: \leq 4 \text{ mm}$ $4 - 5 \text{ GHz}: \leq 3 \text{ mm}$ $5 - 6 \text{ GHz}: \leq 2 \text{ mm}$
Minimum zoom scan volume: x, y, z	$\geq 30 \text{ mm}$	$3 - 4 \text{ GHz}: \geq 28 \text{ mm}$ $4 - 5 \text{ GHz}: \geq 25 \text{ mm}$ $5 - 6 \text{ GHz}: \geq 22 \text{ mm}$

Power Drift Measurement

A second single point SAR measurement is done at the same location as the power reference measurement. The delta between the power reference measurement and the power drift measurement shall not be more than $\pm 5\%$

4.5.8 Measurement Uncertainty

4.5.8.1 IEEE 1528-2013, 300 MHz - 3 GHz

Error Description	Uncertainty Value	Probability Distribution	Divisor	(c) 1g	(c) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(v) v _{eff}
Measurement System								
Probe Calibration	± 6.0%	N	1	1	1	± 6.0%	± 6.0%	∞
Axial Isotropy	± 4.7%	R	√3	0.7	0.7	± 1.9%	± 1.9%	∞
Hemispherical Isotropy	± 9.6%	R	√3	0.7	0.7	± 3.9%	± 3.9%	∞
Boundary Effects	± 1.0%	R	√3	1	1	± 0.6%	± 0.6%	∞
Linearity	± 4.7%	R	√3	1	1	± 2.7%	± 2.7%	∞
System Detection Limits	± 1.0%	R	√3	1	1	± 0.6%	± 0.6%	∞
Modulation Response	± 2.4%	R	√3	1	1	± 1.4%	± 1.4%	∞
Readout Electronics	± 0.3%	N	1	1	1	± 0.3%	± 0.3%	∞
Response Time	± 0.8%	R	√3	1	1	± 0.5%	± 0.5%	∞
Integration Time	± 2.6%	R	√3	1	1	± 1.5%	± 1.5%	∞
RF Ambient Noise	± 3.0%	R	√3	1	1	± 1.7%	± 1.7%	∞
RF Ambient Reflections	± 3.0%	R	√3	1	1	± 1.7%	± 1.7%	∞
Probe Positioner	± 0.4%	R	√3	1	1	± 0.2%	± 0.2%	∞
Probe Positioning	± 2.9%	R	√3	1	1	± 1.7%	± 1.7%	∞
Max. SAR Evaluation	± 2.0%	R	√3	1	1	± 1.2%	± 1.2%	∞
Test Sample Related								
Device Positioning	± 2.9%	N	1	1	1	± 2.9%	± 2.9%	145
Device Holder	± 3.6%	N	1	1	1	± 3.6%	± 3.6%	5
Power Drift	± 5.0%	R	√3	1	1	± 2.9%	± 2.9%	∞
Power Scaling	± 0%	R	√3	1	1	± 0.0%	± 0.0%	∞
Phantom and Setup								
Phantom Uncertainty	± 6.1%	R	√3	1	1	± 3.5%	± 3.5%	∞
SAR correction	± 1.9%	R	√3	1	0.84	± 1.1%	± 0.9%	∞
Liquid Conductivity (mea.) ^{DAK}	± 2.5%	R	√3	0.78	0.71	± 1.1%	± 1.0%	∞
Liquid Permittivity (mea.) ^{DAK}	± 2.5%	R	√3	0.26	0.26	± 0.3%	± 0.4%	∞
Temp. unc. - Conductivity	± 3.4%	R	√3	0.78	0.71	± 1.5%	± 1.4%	∞
Temp. unc. - Permittivity	± 0.4%	R	√3	0.23	0.26	± 0.1%	± 0.1%	∞
Combined Std. Uncertainty						± 11.2%	± 11.1%	361
Expanded STD Uncertainty						± 22.3%	± 22.2%	

4.5.8.2 IEEE 1528-2013, 3 GHz – 6 GHz

Error Description	Uncertainty Value	Probability Distribution	Divisor	(c) 1g	(c) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(v) v _{eff}
Measurement System								
Probe Calibration	± 6.55%	N	1	1	1	± 6.55%	± 6.55%	∞
Axial Isotropy	± 4.7%	R	√3	0.7	0.7	± 1.9%	± 1.9%	∞
Hemispherical Isotropy	± 9.6%	R	√3	0.7	0.7	± 3.9%	± 3.9%	∞
Boundary Effects	± 2.0%	R	√3	1	1	± 1.2%	± 1.2%	∞
Linearity	± 4.7%	R	√3	1	1	± 2.7%	± 2.7%	∞
System Detection Limits	± 1.0%	R	√3	1	1	± 0.6%	± 0.6%	∞
Modulation Response	± 2.4%	R	√3	1	1	± 1.4%	± 1.4%	∞
Readout Electronics	± 0.3%	N	1	1	1	± 0.3%	± 0.3%	∞
Response Time	± 0.8%	R	√3	1	1	± 0.5%	± 0.5%	∞
Integration Time	± 2.6%	R	√3	1	1	± 1.5%	± 1.5%	∞
RF Ambient Noise	± 3.0%	R	√3	1	1	± 1.7%	± 1.7%	∞
RF Ambient Reflections	± 3.0%	R	√3	1	1	± 1.7%	± 1.7%	∞
Probe Positioner	± 0.8%	R	√3	1	1	± 0.5%	± 0.5%	∞
Probe Positioning	± 6.7%	R	√3	1	1	± 3.9%	± 3.9%	∞
Max. SAR Evaluation	± 4.0%	R	√3	1	1	± 2.3%	± 2.3%	∞
Test Sample Related								
Device Positioning	± 2.9%	N	1	1	1	± 2.9%	± 2.9%	145
Device Holder	± 3.6%	N	1	1	1	± 3.6%	± 3.6%	5
Power Drift	± 5.0%	R	√3	1	1	± 2.9%	± 2.9%	∞
Power Scaling	± 0%	R	√3	1	1	± 0.0%	± 0.0%	∞
Phantom and Setup								
Phantom Uncertainty	± 6.6%	R	√3	1	1	± 3.8%	± 3.8%	∞
SAR correction	± 1.9%	R	√3	1	0.84	± 1.1%	± 0.9%	∞
Liquid Conductivity (mea.) ^{DAK}	± 2.5%	R	√3	0.78	0.71	± 1.1%	± 1.0%	∞
Liquid Permittivity (mea.) ^{DAK}	± 2.5%	R	√3	0.26	0.26	± 0.3%	± 0.4%	∞
Temp. unc. - Conductivity	± 3.4%	R	√3	0.78	0.71	± 1.5%	± 1.4%	∞
Temp. unc. - Permittivity	± 0.4%	R	√3	0.23	0.26	± 0.1%	± 0.1%	∞
Combined Std. Uncertainty						± 12.3%	± 12.2%	748
Expanded STD Uncertainty						± 24.6%	± 24.5%	

4.5.8.3 IEC 62209-1/2, 30 MHz – 6 GHz

Error Description	Uncertainty Value	Probability Distribution	Divisor	(c) 1g	(c) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(v) v _{eff}
Measurement System								
Probe Calibration	± 6.55%	N	1	1	1	± 6.55%	± 6.55%	∞
Axial Isotropy	± 4.70%	R	√3	0.7	0.7	± 1.9%	± 1.9%	∞
Hemispherical Isotropy	± 9.60%	R	√3	0.7	0.7	± 3.9%	± 3.9%	∞
Boundary Effects	± 2.00%	R	√3	1	1	± 1.2%	± 1.2%	∞
Linearity	± 4.70%	R	√3	1	1	± 2.7%	± 2.7%	∞
System Detection Limits	± 1.00%	R	√3	1	1	± 0.6%	± 0.6%	∞
Modulation Response	± 2.40%	R	√3	1	1	± 1.4%	± 1.4%	∞
Readout Electronics	± 0.30%	N	1	1	1	± 0.3%	± 0.3%	∞
Response Time	± 0.80%	R	√3	1	1	± 0.5%	± 0.5%	∞
Integration Time	± 2.60%	R	√3	1	1	± 1.5%	± 1.5%	∞
RF Ambient Noise	± 3.00%	R	√3	1	1	± 1.7%	± 1.7%	∞
RF Ambient Reflections	± 3.00%	R	√3	1	1	± 1.7%	± 1.7%	∞
Probe Positioner	± 0.80%	R	√3	1	1	± 0.5%	± 0.5%	∞
Probe Positioning	± 6.70%	R	√3	1	1	± 3.9%	± 3.9%	∞
Post-processing	± 4.00%	R	√3	1	1	± 2.3%	± 2.3%	∞
Test Sample Related								
Device Positioning	± 2.90%	N	1	1	1	± 2.9%	± 2.9%	145
Device Holder	± 3.60%	N	1	1	1	± 3.6%	± 3.6%	5
Power Drift	± 5.00%	R	√3	1	1	± 2.9%	± 2.9%	∞
Power Scaling	± 0%	R	√3	1	1	± 0.0%	± 0.0%	∞
Phantom and Setup								
Phantom Uncertainty	± 7.90%	R	√3	1	1	± 4.6%	± 4.6%	∞
SAR correction	± 1.90%	R	√3	1	0.84	± 1.1%	± 0.9%	∞
Liquid Conductivity (mea.) ^{DAK}	± 2.50%	R	√3	0.78	0.71	± 1.1%	± 1.0%	∞
Liquid Permittivity (mea.) ^{DAK}	± 2.50%	R	√3	0.26	0.26	± 0.4%	± 0.4%	∞
Temp. unc. - Conductivity	± 3.40%	R	√3	0.78	0.71	± 1.5%	± 1.4%	∞
Temp. unc. - Permittivity	± 0.40%	R	√3	0.23	0.26	± 0.1%	± 0.1%	∞
Combined Std. Uncertainty						± 12.5%	± 12.5%	748
Expanded STD Uncertainty						± 25.1%	± 25.0%	

4.6 SAR Scaling (Reported SAR)

Measured 1g and 10g SAR values are scaled up to the maximum output power including tolerance of the EUT as declared by the manufacturer. Conducted output power measurements are performed to ensure the output power of the EUT is close to the maximum power. After SAR measurements are performed, the measured SAR is scaled up by the delta between the measured output power and the manufacturer's declared maximum output power including tolerance.

The SAR scaling factor is calculated as

$$\text{SAR Scaling Factor} = \frac{\text{Maximum Output Power Including Tolerance, mW}}{\text{Measured Output Power, mW}}$$

The reported SAR is

$$\text{Reported SAR} = \text{Measured SAR} \times \text{SAR Scaling Factor}$$

For Example:

Measured SAR: 1.0 W/kg

Measured output power: 250 mW

Maximum output power including tolerance: 300 mW

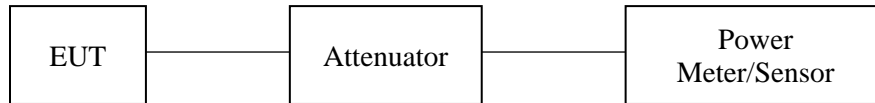
SAR scaling factor = 1.2

Reported SAR = 1.2 W/kg

5 Conducted Output Power Measurements

Conducted output power measurements are performed to verify the EUT is transmitting at maximum output power. The power measurements are compared to the manufacturer's declared output power including tolerance.

The following set up is used for conducted output power measurements



The following path losses were used during conducted measurements

Frequency (MHz)	Attenuator (dB)	Total Path Loss (dB)
2400 – 2483.5	20	21
5180 – 5250	20	21.5
5250 – 5725	10	11.5
5725 – 5850	20	21.5

5.1 WLAN

Output power is measured using a power meter.

2.4 GHz WLAN – 802.11 b/g/n

		802.11b	802.11g	802.11n, HT20
Duty Cycle		100%	100%	100%
Ch. 1 / 2412 MHz	Measured Burst Avg. Power (dBm)	13.2	13	13.4
	Max Output Power Including Tolerance (dBm)	14	14	14
Ch. 2 / 2417 MHz	Measured Burst Avg. Power (dBm)	13.3	12.8	13.3
	Max Output Power Including Tolerance (dBm)	14	14	14
Ch. 3 / 2422 MHz	Measured Burst Avg. Power (dBm)	18.1	17.3	18.1
	Max Output Power Including Tolerance (dBm)	20	19	19
Ch. 6 / 2437 MHz	Measured Burst Avg. Power (dBm)	18.3	17.3	18
	Max Output Power Including Tolerance (dBm)	20	19	19
Ch. 9 / 2452 MHz	Measured Burst Avg. Power (dBm)	18.4	17.5	18.5
	Max Output Power Including Tolerance (dBm)	20	19	19
Ch. 10 / 2462 MHz	Measured Burst Avg. Power (dBm)	14	12.6	13.7
	Max Output Power Including Tolerance (dBm)	14	14	14
Ch. 11 / 2462 MHz	Measured Burst Avg. Power (dBm)	13.7	12.5	13.7
	Max Output Power Including Tolerance (dBm)	14	14	14

UNII-1 WLAN – 802.11 a/n; 20 MHz Bandwidth

		802.11a	802.11n, HT20
Duty Cycle		100%	100%
Ch. 36 / 5180 MHz	Measured Burst Avg. Power (dBm)	11.4	10.7
	Max Output Power Including Tolerance (dBm)	12	11
Ch. 40 / 5200 MHz	Measured Burst Avg. Power (dBm)	10.5	10.9
	Max Output Power Including Tolerance (dBm)	12	11
Ch. 44 / 5220 MHz	Measured Burst Avg. Power (dBm)	11.6	10.8
	Max Output Power Including Tolerance (dBm)	12	11
Ch. 48 / 5240 MHz	Measured Burst Avg. Power (dBm)	11.4	10.8
	Max Output Power Including Tolerance (dBm)	12	11

UNII-2A WLAN – 802.11 a/n/ac; 20 MHz Bandwidth

		802.11a	802.11n, HT20
Duty Cycle		100%	100%
Ch. 52 / 5260 MHz	Measured Burst Avg. Power (dBm)	10.01	9.3
	Max Output Power Including Tolerance (dBm)	12	11
Ch. 56 / 5280 MHz	Measured Burst Avg. Power (dBm)	10.03	9.2
	Max Output Power Including Tolerance (dBm)	12	11
Ch. 60 / 5300 MHz	Measured Burst Avg. Power (dBm)	10.2	10.1
	Max Output Power Including Tolerance (dBm)	12	11
Ch. 64 / 5320 MHz	Measured Burst Avg. Power (dBm)	10.05	10.1
	Max Output Power Including Tolerance (dBm)	12	11

UNII-2C WLAN – 802.11 a/n/ac; 20 MHz Bandwidth

Duty Cycle		802.11a	802.11n, HT20
Ch. 100 / 5500 MHz	Measured Burst Avg. Power (dBm)	10.03	9.9
	Max Output Power Including Tolerance (dBm)	12	11
Ch. 108 / 5540 MHz	Measured Burst Avg. Power (dBm)	10.1	9.4
	Max Output Power Including Tolerance (dBm)	12	11
Ch. 112 / 5560 MHz	Measured Burst Avg. Power (dBm)	10.1	10.2
	Max Output Power Including Tolerance (dBm)	12	11
Ch. 116 / 5580 MHz	Measured Burst Avg. Power (dBm)	10.2	10.2
	Max Output Power Including Tolerance (dBm)	12	11
Ch. 120 / 5600 MHz	Measured Burst Avg. Power (dBm)	10.6	10.3
	Max Output Power Including Tolerance (dBm)	12	11
Ch. 124 / 5620 MHz	Measured Burst Avg. Power (dBm)	10	10.3
	Max Output Power Including Tolerance (dBm)	12	11
Ch. 128 / 5640 MHz	Measured Burst Avg. Power (dBm)	10.6	10.5
	Max Output Power Including Tolerance (dBm)	12	11
Ch. 132 / 5660 MHz	Measured Burst Avg. Power (dBm)	10.5	10.9
	Max Output Power Including Tolerance (dBm)	12	11
Ch. 136 / 5680 MHz	Measured Burst Avg. Power (dBm)	10.3	10.7
	Max Output Power Including Tolerance (dBm)	12	11

		802.11a	802.11n, HT20
Duty Cycle		100%	100%
Ch. 140 / 5700 MHz	Measured Burst Avg. Power (dBm)	10.2	10.1
	Max Output Power Including Tolerance (dBm)	12	11
Ch. 144 / 5720 MHz	Measured Burst Avg. Power (dBm)	10.2	10.5
	Max Output Power Including Tolerance (dBm)	12	11

UNII-3 WLAN – 802.11 a/n/ac; 20 MHz Bandwidth

		802.11a	802.11n, HT20
Duty Cycle		100%	100%
Ch. 149 / 5745 MHz	Measured Burst Avg. Power (dBm)	10.3	10.2
	Max Output Power Including Tolerance (dBm)	12	11
Ch. 157 / 5785 MHz	Measured Burst Avg. Power (dBm)	10.6	10.6
	Max Output Power Including Tolerance (dBm)	12	11
Ch. 165 / 5825 MHz	Measured Burst Avg. Power (dBm)	10.4	10.1
	Max Output Power Including Tolerance (dBm)	12	11

6 SAR Measurement Results

6.1 SAR Evaluation Exclusion

6.1.1 KDB 248227 Exclusions

According to KDB 248227, SAR testing for 802.11g/n can be excluded when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.

Maximum Power for 802.11b: 20 dBm

Maximum Power for 802.11g/n: 19 dBm

Highest Reported SAR for 802.11b: 1.10W/kg

Adjust 802.11g/n SAR: 0.875 W/kg

SAR evaluation for 802.11g/n is not required.

6.2 Liquid Measurements

Liquid measurements are within +/-10% of the target value. The DASY52 software corrects the measured SAR value to the target conductivity and permittivity only when the SAR value will be higher after correction.

Liquid	Date	Frequency	Measured		% Delta	
			Permittivity	Conductivity	Permittivity	Conductivity
HBBL 600-6000V6	November 12, 2018	5180	33.1664	4.38627	-7.89305	-5.35621
		5200	33.1377	4.40331	-7.91438	-5.40691
		5220	33.1083	4.41959	-7.93751	-5.47333
		5240	33.0765	4.43709	-7.96741	-5.51345
		5745	32.2514	5.00565	-8.7988	-3.98908
		5785	32.1837	5.05102	-8.87236	-3.87484
		5800	32.1571	5.06824	-8.90346	-3.82849
		5825	32.1087	5.09849	-8.96681	-3.72255
	April 9, 2019	5500	32.9191	4.79038	-7.64183	-3.46839
		5540	32.8562	4.83492	-7.69991	-3.36917
		5600	32.7592	4.90059	-7.79484	-3.24605
		5620	32.7228	4.92344	-7.83781	-3.18677
		5680	32.614	4.98881	-7.96666	-3.07341
		5720	32.5413	5.03412	-8.05309	-2.96609
		5800	32.3949	5.12664	-8.22964	-2.72036
	April 10, 2019	2420	38.1259	1.81725	-2.87211	2.47648
		2425	38.1182	1.82107	-2.86977	2.43543
		2435	38.1025	1.82878	-2.86585	2.35728
		2440	38.0946	1.83264	-2.86396	2.31886
		2450	38.0788	1.84036	-2.86015	2.24205
		2455	38.0709	1.84421	-2.86446	2.14662
		5200	33.2439	4.47097	-7.61931	-3.95341
		5260	33.1449	4.53264	-7.71855	-3.89829
		5300	33.0793	4.57338	-7.78378	-3.87016
		5320	33.0485	4.59407	-7.81077	-3.84951

6.3 System Check

System check is performed within 24 hours before the SAR measurement on the EUT. A SAR measurement is done with a calibrated reference dipole. The measured SAR is normalized to 1 W and compared to the 1 W reference SAR value provided in the calibration report for the dipole. The system check is verified to be within $\pm 10\%$ of the reference SAR value.

Frequency (MHz)	Liquid Type	Date	Dipole Input Power (mW)	1 W Normalized 1g SAR (W/kg)	1 W Reference 1g SAR (W/kg)	Difference
2450	HBBL	April 10, 2019	20	59.64	54.4	9.6%
5200	HBBL	November 12, 2018	20	74.51	75.0	-0.7%
5200	HBBL	April 10, 2019	20	76.52	75.0	2.0%
5500	HBBL	April 9, 2019	20	87.67	83.6	4.9%
5800	HBBL	November 12, 2018	20	82.70	82.4	0.4%
5800	HBBL	April 9, 2019	20	90.39	82.4	9.5

6.4 Test Configurations

The following configurations were tested for SAR.

Configuration #	Exposure Condition	Accessories	Position	Distance
B1	Body	None	Front	0 mm
B2			Back	0 mm
B3			Right Edge	0 mm
B4			Bottom Edge	0 mm

6.5 Body SAR Results

802.11b

The power is reduced for channels 1, 2, 10, and 11. The low, middle, and high channels used for SAR evaluation are channels 3, 6, and 9.

Channel	Frequency (MHz)	Config. #	Power Drift (dB)	Measured 1g SAR (W/kg)	SAR Scaling Factor	Scaled 1g SAR (W/kg)	Plot #
3	2422	B3	-0.07	0.514	1.55	1.10	Plot 1
6	2437	B1	-0.18	0.163	1.48	0.241	Plot 2
6	2437	B2	0.00	0.090	1.48	0.133	Plot 3
6	2437	B3	-0.04	0.393	1.48	0.581	Plot 4
6	2437	B4	0.16	0.00386	1.48	0.006	Plot 5
9	2452	B3	-0.02	0.762	1.45	0.796	Plot 6

802.11a, UNII-1 (5180 – 5250 MHz)

Channel	Frequency (MHz)	Config. #	Power Drift (dB)	Measured 1g SAR (W/kg)	SAR Scaling Factor	Scaled 1g SAR (W/kg)	Plot #
44	5220	B1	0.18	0.033	1.10	0.036	Plot 7
44	5220	B2	0.19	0.043	1.10	0.047	Plot 8
44	5220	B3	0.11	0.200	1.10	0.219	Plot 9
44	5220	B4	0	0.00404	1.10	0.004	Plot 10

802.11a, UNII-2A (5250 – 5350 MHz)

Channel	Frequency (MHz)	Config. #	Power Drift (dB)	Measured 1g SAR (W/kg)	SAR Scaling Factor	Scaled 1g SAR (W/kg)	Plot #
60	5300	B1	0	0.023	1.51	0.035	Plot 11
60	5300	B2	0	0.021	1.51	0.031	Plot 12
60	5300	B3	0.19	0.072	1.51	0.109	Plot 13
60	5300	B4	0	0.000152	1.51	0.000	Plot 14

802.11a, UNII-2C (5470 – 5725 MHz)

Channel	Frequency (MHz)	Config. #	Power Drift (dB)	Measured 1g SAR (W/kg)	SAR Scaling Factor	Scaled 1g SAR (W/kg)	Plot #
108	5540	B1	0	0.093	1.55	0.145	Plot 15
108	5540	B2	0.08	0.041	1.55	0.063	Plot 16
108	5540	B3	0.06	0.271	1.55	0.420	Plot 17
108	5540	B4	0	0.023	1.55	0.036	Plot 18
136	5680	B1	0	0.070	1.48	0.103	Plot 19
136	5680	B2	0	0.033	1.48	0.048	Plot 20
136	5680	B3	0.18	0.246	1.48	0.364	Plot 21
136	5680	B4	0	0.023	1.48	0.034	Plot 22

802.11a, UNII-3 (5725 – 5850 MHz)

Channel	Frequency (MHz)	Config. #	Power Drift (dB)	Measured 1g SAR (W/kg)	SAR Scaling Factor	Scaled 1g SAR (W/kg)	Plot #
157	5785	B1	0.03	0.070	1.38	0.097	Plot 23
157	5785	B2	-0.19	0.027	1.38	0.038	Plot 24
157	5785	B3	-0.04	0.164	1.38	0.226	Plot 25
157	5785	B4	0.14	0.054	1.38	0.074	Plot 26

6.6 Measurement Variability

According to FCC KDB 865664, 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. SAR measurement variability is assessed for each frequency band for the tissue simulating liquid with the highest measured SAR and using the highest measured SAR configuration. The following procedure is used to assess measurement variability:

1. Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.
2. When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
3. Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg ($\sim 10\%$ from the 1-g SAR limit).
4. Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20 .

7 Test Equipment List

Equipment	Test Dates	Manufacturer	Model #	Serial/Inst #	Last Cal mm/dd/yyyy	Next Cal mm/dd/yyyy
2450 MHz Dipole	November 12, 2018, April 9-11, 2019	IMST	diSARA2450	304324-2402103	10/16/2018	10/16/2019
5000 MHz Dipole	November 12, 2018, April 9-11, 2019	IMST	diSARA5000	304350-5002103	10/18/2018	10/18/2019
DASY5 Robot	November 12, 2018, April 9-11, 2019	Staubli	TX60L	F13/5R4XC1/A/01	N/A	N/A
DASY5 Robot Controller	November 12, 2018, April 9-11, 2019	Staubli	CS8Cspeag-TX60	F13/5R4XC1/C/01	N/A	N/A
DASY5 Measurement Server	November 12, 2018, April 9-11, 2019	SPEAG	SE UMS 011 DA	1398	N/A	N/A
Data Acquisition Electronics	November 12, 2018	SPEAG	DAE4	1419	03/19/2018	03/19/2019
Data Acquisition Electronics	April 9-11, 2019	SPEAG	DAE4	1419	02/01/2019	02/01/2020
SAR Probe	November 12, 2018	SPEAG	EX3DV4	3957	03/26/2018	03/26/2019
SAR Probe	April 9-11, 2019	SPEAG	EX3DV4	7350	12/14/2018	12/14/2019
SAM Phantom	November 12, 2018, April 9-11, 2019	SPEAG	QD 000P40 CD	1806	N/A	N/A
ELI Phantom	November 12, 2018, April 9-11, 2019	SPEAG	QD OVA 002 AA	2154	N/A	N/A
Head Liquid 600 MHz – 6 GHz	November 12, 2018, April 9-11, 2019	SPEAG	HBBL	161114-1	N/A	N/A
Dielectric Assessment Kit	November 12, 2018	SPEAG	DAKS-3.5	1079	01/16/2018	01/16/2019
Dielectric Assessment Kit	April 9-11, 2019	SPEAG	DAKS-3.5	1079	02/12/2019	02/12/2020
Submersible Digital Thermometer	November 12, 2018, April 9-11, 2019	LKM Electronic	DTM 3000	3641	03/14/2018	03/14/2020
Temperature Sensor	November 12, 2018, April 9-11, 2019	Control Company	4184	170255262	03/16/2017	03/16/2020

8 Revision History

The latest revision replaces all previous versions

Revision No.	Date	Reason for change	Author
0	April 18, 2019	Original	JS
1	August 21, 2019	Added list of DUTs to section 3.7 Updated equipment list	JS
2	September 27, 2019	Updated EUT serial number	JS
3	October 9, 2019	Updated section 5.1 and Appendix A	JS