SAR TEST REPORT

for

MODEL NO. 1964
FCC ID: C3K1964

Test Report No. S-677-FCC-SAR-1
Issue Date: July 16, 2021

FCC CFR 47 PART 2.1093

IEEE 1528-2013

Prepared by
Microsoft EMC Laboratory
17760 NE 67th Ct,
Redmond WA, 98052, U.S.A.
425-421-9799

TESTING CERT #3472.01

1 Record of Revisions

Revision	Date	Section	Page(s)	Summary of Changes	Author/Revised By:
1.0	07/16/2019	All	All	First Version	Wei Sun

Test Report Attestation

Microsoft Corporation
Model: 1964

Applicable Standards

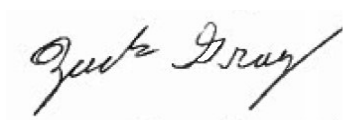
Specification	Test Result
FCC CFR 47 PART 2.1093 IEEE 1528-2013	Pass

Microsoft EMC Laboratory attests that the product model identified in this report has been tested to and meets the requirements identified in the above standards. The test results in this report solely pertains to the specific sample tested, under the conditions and operating modes as provided by the customer.

This report shall not be used to claim product certification, approval, or endorsement by A2LA or any agency of any Government. Reproduction, duplication or publication of extracts from this test report is prohibited and requires prior written approval of Microsoft EMC Laboratory.

Written By: Wei Sun

SAR/Radio Test Engineer



Reviewed/ Issued By: Zack Gray

SAR Test Lead

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2 Deviations from Standard

None.

3 Facilities and Accreditation

3.1 TEST FACILITY

All test facilities used to collect the test data are located at Microsoft EMC Laboratory: 17760 NE 67th Ct, Redmond, WA, 98052, USA.

3.2 ACCREDITATIONS

The lab is established and follows procedures as outlined in IEC/ISO 17025 and A2LA accreditation requirements.

A2LA Accredited Testing Certificate Number: 3472.01
Expiration Date: Aug 31, 2021

3.3 Test Equipment

The site and related equipment are constructed in conformance with the requirements of IEEE 1528-2013 and other equivalent applicable standards.
The calibrations of the measuring instruments, including any accessories that may affect such calibration, are checked frequently to assure their accuracy. Adjustments are made and correction factors are applied in accordance with instructions contained in the user manual for the measuring equipment.

4 Highest Reported SAR Values

Exposure Condition	Mode of Operation	Test Position	1-g Reported SAR (W/kg)
Body Exposure	NFC Charging	Front	0.0167

4.1 SAR Limits

The following are the relevant SAR limits for FCC and IC based on the recommendations of ANSI C95.1-1992:

Exposure Condition	Limit (W/kg)
Localized Body SAR	1.6 (1-g cube)

5 Test Equipment List

Manufacturer	Description	Model	SN	Identifier	Cal. Due	Cal. Cycle
Agilent	Signal Generator	N5181A	MY50144791	SAR-051	12/31/2021	1 yr
Agilent	Power Meter	1914A	MY50901710	SAR-052	1/6/2022	1 yr
Agilent	Power Sensor	E9304A	MY60270015	EMC-1426	9/23/2021	1 yr
Agilent	Network Analyzer	E5071C	MY46316847	SAR-002	3/19/2022	1 yr
SPEAG	DAK-12 Probe	SM DAK 020 BA	1145	SAR-172	7/11/2022	1 yr
SPEAG	DASY Data Acquisition Electronics	DAE4	1383	SAR-034	5/11/2022	1 yr
SPEAG	Dosimetric E-Field Probe	EX3DV4	3999	SAR-108	5/25/2022	1 yr
SPEAG	SAR Validation Coil, 13 MHz	CLA13	1006	SAR-162	5/10/2022	1 yr
SPEAG	Tri-Flat Phantom	MFP V5.1C	1144/1	N/A	N/A	N/A
Thomas Scientific	Thermometer	1230N27	192651858	SAR -180	11/18/2021	1 yr
MadgeTech	THP Monitor	PRHTemp2000	P25367	EMC- 881	12/17/2021	1 yr

6 Product Description

Company Name:	Microsoft Corporation
Address:	One Microsoft Way
City, State, Zip:	Redmond, WA 98052
Customer Contact:	Mike Boucher
Functional Description of the EUT:	Portable Computing Device
RF Exposure Conditions:	Body Exposure
Model:	1964
FCC ID:	C3K1964
IC ID:	3048A-1964
Radio Descriptions:	NFC Charging @ 13.56 MHz
Modulations:	Charging: CW, No modulation Data Communication: ASK
Equipment Design State:	Prototype/Production Equivalent
Equipment Condition:	Good
Dates of Testing:	07/08/2021 – 07/09/2021

6.1 TEST CONFIGURATIONS

Test firmware provided by the customer was used to program the EUT to transmit continuously at maximum power. The EUT was charging the companion client device via NFC at maximum power for the duration of the tests.

6.2 ENVIRONMENTAL CONDITIONS

Ambient air temperature of the test site was within the range of 18 ºC to 25 ºC. Testing conditions were within tolerance and any deviations required from the EUT are reported.

6.3 EQUIPMENT MODIFICATIONS

No modifications were made during testing.

6.4 EQUIPMENT UNDER TEST

Model Number	Serial Number
1964	0F0006R211400C

6.4.1 Accessory Test Equipment

Description	Serial Number
Companion Device (Charging Client)	0F0003T212300D
Companion Device (Charging Client)	0F0004U212300D
Companion Device (Charging Client)	0F0004L212300D
Companion Device (Charging Client)	0F0004P212300D
Companion Device (Charging Client)	0F0004J212300D

7 Test Methodology

Test setup and procedure are performed according to **IEEE 1528-2013 Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques.**

In addition, the following publications were used as guidance-

For FCC SAR testing and reporting according to FCC standards the following KDBs were adhered to:

- 447498 D01 General RF Exposure Guidance v06
- 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04
- 865664 D02 RF Exposure Reporting v01r02
- 680106 D01 RF Exposure Wireless Charging App v03r01
- RF Exposure Procedures from May 2017 TCB Workshop

8 Test Configurations

8.1 Test Positions

The EUT was tested on all device faces and edges near the transmitting coil in both tablet and laptop configurations. The client device was attached for charging since the NFC will only transmit when the client is attached in the proper location.

Exposure Condition	Phantom Used	DUT Test Position	Test Setup Photo (See Appendix)
Body	Flat Section (SAM, ELI, or Triple-Flat)	Tablet Mode Closed Back	Photo 1
		Laptop Mode Open Back	Photo 2
		Tablet Mode Closed Top Edge	Photo 3
		Laptop Mode Open Keyboard Touch	Photo 4
		Tablet Mode Closed Left Edge	Photo 5
		Tablet Mode Closed Right Edge	Photo 6

9 SAR Test Procedures

The SAR Evaluation was performed in the following steps:

- **Power Reference Measurement.**
  The Power Measurement and Power Drift Measurements are for monitoring the power drift of the device under test. 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 set to 2mm for the EX3DV4 probe as recommended by SPEAG. The Power Reference Measurement is taken at a point close to the antenna whose output is being measured in order to maximize SNR, thus minimizing drift error.

- **Area Scan**
  The Area Scan is used as a fast scan in two dimensions to find the areas of high field values (or hot spots), before doing a fine measurement around the hotspot. The sophisticated interpolation routines implemented in DASY5 software can find the maximum locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maxima found and lists all maxima found in the scan area within a certain range of the global maximum. A 2 dB range is required by IEC 62209-2. Zoom scans need only be performed on all secondary maxima within this range when the absolute maximum found is under 2 dB less than the SAR limit in question (i.e., less than 1 W/kg for the 1.6 W/kg SAR limit), and the secondary maxima would lie outside the zoom scan of the primary maxima. Otherwise, the zoom scan is only performed at the highest maxima found in the area scan. The exception to this is in MIMO configurations where at least one zoom scan may be measured per transmit antenna.

  The following x-y grid spacings or smaller for the given transmitter frequency ranges are used for area scans in accordance with IEC 62209-2:2010:

  $f \leq 3$ GHz: ≤ 20 mm
  $f \geq 3$ GHz: $\leq (60/f[GHz])$
  Note: reduced area scan spacing was used due to the size of the EUT' coil.

- **Zoom Scan**
  Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1g or 10g of simulated tissue. When the measurement is done, the Zoom Scan evaluates the averaged SAR for 1g and 10g and displays these values next to the job's label. The sides of the zoom scan cube should be parallel to the edges of the EUT when possible. The dimensions of a Zoom Scan and spacing between measurement points vary by frequency according to IEC 62209-2:2010, shown in the table below:

Transmitter Frequency Range	Cube Dimensions	x-y coordinate spatial resolution	z coordinate spatial resolution
f ≤ 3 GHz	≥ 30 mm	≤ 24/f(GHz), never more than 8 mm	≤ 8 – (f[GHz]), never more than 5 mm
f ≥ 3 GHz	≥ 22 mm	≤ 24/f(GHz), never more than 8 mm	≤ 8 – (f[GHz]), never more than 5 mm

- **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. The absolute value of this difference must be ≤ 0.21 dB; if it is not, the entire test is repeated or the difference accounted for.

10 SAR Test Results

10.1 General SAR Testing Notes

- From **KDB 447498 D01 General RF Exposure Guidance v06**, the following test channel reduction was applied to each test position of an exposure condition in each wireless mode and configuration. Initial testing for each test position for each band was performed on the middle required test channel (or required test channel with the highest measured power for WLAN modes). 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

- Tissue-simulating liquid temperature was maintained within +/- 2°C of that which was measured during liquid verification.

- The SAR of the NFC transmitter is very low and hardly discernible from the system measurement noise floor.

- The 13.56 MHz signal was monitored with a spectrum analyzer to ensure continuous transmission throughout the tests.

- Full area scans exploratory area scans were done covering the entire EUT, but the final data used had smaller area scans focused around the NFC coil with smaller step sizes.

10.1.1 NFC Charging SAR Test Results

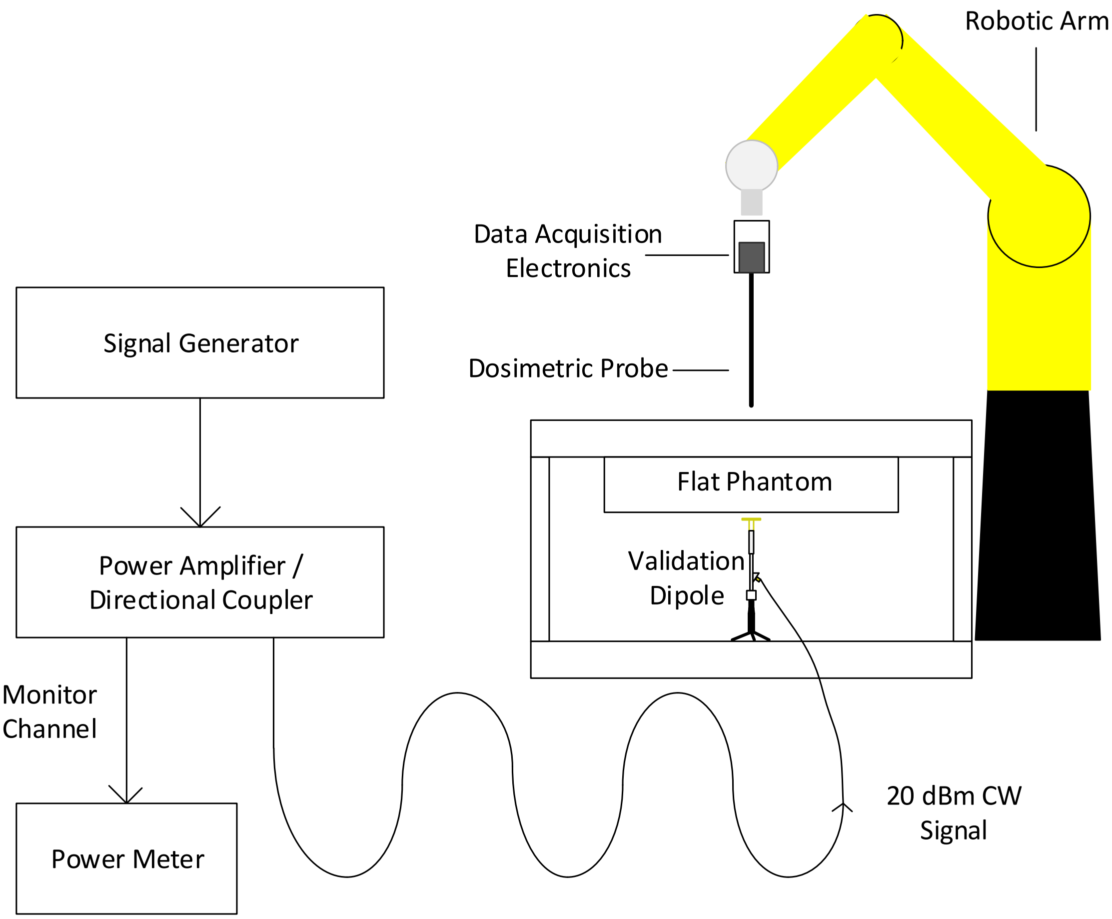
Mode	Ant.	Position	Freq. (MHz)	Meas. 1g SAR (W/kg)	Reported 1g SAR (W/kg)
NFC Charging	default	Tablet Mode Closed Back	13.56	0.0161	0.0161
		Laptop Mode Open Back		0.0167	**0.0167 (Plot 1)**
		Tablet Mode Closed Top Edge		0.00112	0.00112
		Laptop Mode Open Keyboard Touch		0.00153	0.00153
		Tablet Mode Closed Left Edge		-	**-**
		Tablet Mode Closed Right Edge		-	**-**

Note: No hotspot was detected by the system for Tablet Mode, Closed Left Edge and Tablet Mode, Closed Right Edge Mode Positions.

11 SAR System Verification

System Verifications were performed in accordance with **IEC 62209-2** and **IEC/IEEE 62209-1528.** Verifications were 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 liquid combinations used with each SAR system for system verification were used for device testing. Verifications were performed before each series of SAR measurements using the same calibration point and tissue-equivalent medium and every three days thereafter when necessary.

The test setup diagram is shown below. A CW signal is created by a signal generator and fed through a power amplifier with directional coupler outputs. The forward output power is adjusted to 16 dBm while the coupled output power is normalized to 0dB for easy monitoring. When the forward power is attached to the dipole / CLA, the power is then adjusted if necessary so that the coupled channel again reads 0 dB on the power meter. Tissue-simulating liquid depth in the phantom is maintained to be at least 15 cm for frequencies below 3 GHz and 10 cm for frequencies above 5 GHz.



System Verification Setup

11.1 SAR System Verification Results

Verifications is performed with a 44.67 mW (16.5 dBm) input to the Coil. The resultant measured SAR is normalized to 1 W (30 dBm) for comparison to calibrated Coil targets. All normalized SAR system verification results were within 10% of the respective dipole / coil target values.

Date	Tissue-Sim. Liquid	Probe SN	Coil	Freq. (MHz)	Meas. 1-g SAR (W/kg)	Norm. 1-g SAR (W/kg)	Dipole Target 1-g SAR (W/kg)	Dev. from Target 1-g SAR (%)
8/21/2019	HSL	3999	CLA13	13	0.0238	0.53	0.564	**-6.03 (Plot 2)**

12 Tissue-Simulating Liquid Verification

(KDB 854664 D01 v01r04 Section 2.4) The tissue dielectric parameters of tissue-equivalent media used for SAR measurements must be characterized within a temperature range of 18°C to 25°C, measured with calibrated instruments and apparatuses, such as network analyzers and temperature probes. The temperature of the tissue-equivalent medium during SAR measurement must also be within 18°C to 25°C and within ± 2°C of the temperature when the tissue parameters are characterized. The tissue dielectric measurement system must be calibrated before use. 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.

The target parameters for the tissue-simulating liquids are obtained from the following table from IEC/IEEE 62209 – 1528 ED1 2020:

Frequency MHz	Real part of the complex relative permittivity, ε_r'	Conductivity, σ S/m
4	*55,0*	*0,75*
13	*55,0*	*0,75*
30	55,0	0,75
150	52,3	0,76
300	45,3	0,87
450	43,5	0,87
750	*41,9*	*0,89*
835	41,5	0,90
900	41,5	0,97
1 450	40,5	1,20
1 800	40,0	1,40
1 900	40,0	1,40
1 950	40,0	1,40
2 000	40,0	1,40
2 100	*39,8*	*1,49*
2 450	39,2	1,80
2 600	*39,0*	*1,96*
3 000	38,5	2,40
3 500	*37,9*	*2,91*
4 000	*37,4*	*3,43*
4 500	*36,8*	*3,94*
5 000	*36,2*	*4,45*
5 200	*36,0*	*4,66*
5 400	*35,8*	*4,86*
5 600	*35,5*	*5,07*
5 800	35,3	5,27
6 000	35,1	5,48
6 500	34,5	6,07
7 000	33,9	6,65
7 500	33,3	7,24
8 000	32,7	7,84
8 500	32,1	8,46
9 000	31,6	9,08
9 500	31,0	9,71
10 000	30,4	10,40

12.1 Tissue-Simulating Liquid Ingredients and Maintenance

The Tissue-simulating liquids were manufactured by SPEAG. The following information on the maintenance of

MSL 2450 Ingredients: Water, DGBE

MBBL 3500 – 5800 Ingredients: Water, Mineral Oil, Emulsifiers, Sodium Chloride

DGBE BASED LIQUIDS
DGBE is easily dissolved in water. Given a DGBE-water mixture, mainly water will evaporate, however DGBE will evaporate to a smaller percentage. For the frequency liquids around 2.5 GHz, no NaCl is contained and should therefore not be added for any corrections. Evaporated water can be replaced and will mainly increase the permittivity, and to a small extent the conductivity, typically as follows:

HSLxxxxV2: permittivity 0.8 to 1.0 per % of water, conductivity 0 to 0.1 per % of water

MSLxxxxV2: permittivity 0.8 per % of water, conductivity 0 to 0.01 per % of water

OIL BASED LIQUIDS
Oil based liquids are an emulsion of a complex mixture of ingredients. Their appearance is yellow or brown transparent or slightly opaque / milky in most cases. Some older liquids may show a non-transparent upper zone with a creamy appearance after some time without stirring. Before using or handling the liquid, it must therefore be stirred to become entirely homogeneous. An opaque appearance is possible but will not influence the dielectric parameters if it is homogeneous during the measurement at the probe surface. Evaporated water can be replaced and will increase the permittivity, and to a smaller extent the conductivity.

The **sensitivities to water addition** (% parameter increase per weight% water added) of oil based SPEAG broadband tissue simulating liquids at the frequencies of interest are typically in the following range:

HBBL3500-5800V5	at 3.5 GHz:	permittivity 0.79, conductivity 0.14
	at 5.5 GHz:	permittivity 0.83, conductivity 0.41
MBBL3500-5800V5	at 3.5 GHz:	permittivity 0.44, conductivity 0.00
	at 5.5 GHz:	permittivity 0.48, conductivity 0.18

The **temperature gradients** shall be observed especially during conductivity measurement:

HBBL3500-5800V5	at 3.5 GHz:	permittivity -0.07, conductivity -0.43 %/°C
	at 5.5 GHz:	permittivity -0.23, conductivity -0.96 %/°C
MBBL3500-5800V5	at 3.5 GHz:	permittivity -0.35, conductivity -1.14 %/°C
	at 5.5 GHz:	permittivity -0.08, conductivity -1.52 %/°C

12.2 Tissue-Simulating Liquid Measurements

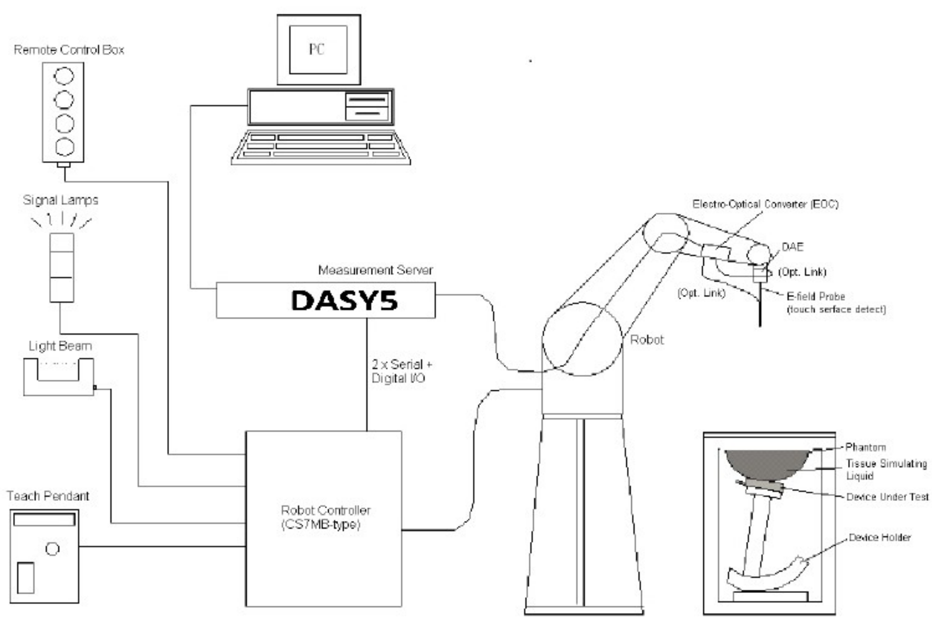
Date	Tissue-Simulating Liquid	Freq. (MHz)	Rel. Perm. ε'_r	Target ε'_r	ε'_r Dev. %	Cond. σ (S/m)	Target σ (S/m)	σ Dev. %
7/8/2021	HBBL 30-250 V3 171115-1 22.4 °C	13	53.74	55	**-2.29**	0.77	0.75	**2.67**
		13.5	54.3	55	**-1.27**	0.77	0.75	**2.67**
		14	54.23	55	**-1.4**	0.77	0.75	**2.67**

13 System Specification

13.1 SPEAG DASY5 SYSTEM

DASY 5 system performing SAR testing contains the following items, which are illustrated in the figure below.

- 6-axis robot (model: TX90XL) with controller and teach pendant.
- Dosimetric E-field probe.
- Light beam unit which allows automatic "tooling" of the probe.
- The electro-optical convertor (EOC) which is mounted on the robot arm.
- The data acquisition electronics (DAE).
- Elliptical Phantom
- Device holder.
- Remote control.
- PC.
- DASY5 software.
- Validation dipole.



DASY5 System Setup

14 Measurement Uncertainty

DASY5 Uncertainty Budget (0.3 – 6 GHz range) According to IEC/EN 62209-2								
Error Description	**Uncer. Value**	**Prob. Dist.**	**Div.**	c_i **1g**	c_i **10g**	**Std. Unc. (1g)**	**Std. Unc. (10g)**	(v_i) 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 Effect	2.0	R	√3	1	1	1.2	1.2	∞
Linearity	4.7	R	√3	1	1	2.7	2.7	∞
Modulation Response	2.4	R	√3	1	1	1.4	1.4	∞
System Detection Limits	1.0	R	√3	1	1	0.6	0.6	∞
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 Mechanical Tolerance	0.8	R	√3	1	1	0.5	0.5	∞
Probe Positioning with respect to Phantom Shell	6.7	R	√3	1	1	3.9	3.9	∞
Post Processing	4.0	R	√3	1	1	2.3	2.3	∞
Test sample Related								
Test Sample Positioning	2.9	N	1	1	1	3.6	3.5	29
Device Holder Uncertainty	3.6	N	1	1	1	3.6	3.6	5
Power Scaling	0	R	√3	1	1	0.0	0..0	∞
Output Power Variation - SAR drift measurement	5.0	R	√3	1	1	2.9	2.9	∞
Phantom and Tissue Parameters								
Phantom Uncertainty (shape and thickness tolerances)	7.9	R	√3	1	1	4.6	4.6	∞
SAR Correction	1.9	R	√3	1	0.84	1.1	0.9	∞
Liquid Conductivity - measurement uncertainty	2.5	R	√3	0.78	0.71	1.1	1.0	∞
Liquid Permittivity - measurement uncertainty	2.5	R	√3	0.26	0.26	0.3	0.4	∞
Temperature Uncertainty – Conductivity	3.4	R	√3	0.78	0.71	1.5	1.4	∞
Temperature Uncertainty – Permittivity	0.4	R	√3	0.23	0.26	0.1	0.1	∞
Combined Standard Uncertainty		RSS				**12.7**	12.7	661
Expanded Uncertainty (95% CONFIDENCE INTERVAL)		*k*= 2				**25.5%**	25.3%	

15 Appendices

The following are contained in the attached appendices:

- Highest SAR Test and SAR System Verification Plots
- SAR Test Setup Photos
- Calibration Report Documents for:
    - Validation Coil CLA13-1006_May21
    - Dosimetric Probe EX3DV4-3999_May21

End of Test Report