

**TEST REPORT****Report Number: 103985132MPK-002****Project Number: G103985132****August 02, 2019****Testing performed on the  
Philips Sonicare DiamondClean****Model(s) Tested: HX991B, HX991W****FCC ID: 2ADZNHX991****IC: 20109-HX991****to****FCC Part 15 Subpart C (15.225)****Industry Canada RSS-210 Issue 9****For****Philips Oral Healthcare LLC**

Test Performed by:

Intertek

1365 Adams Court

Menlo Park, CA 94025 USA

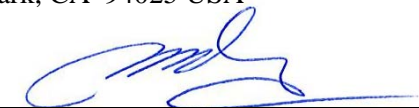
Test Authorized by:

Philips Oral Healthcare LLC

22100 Bothell Everett Highway

Bothell, WA 98021

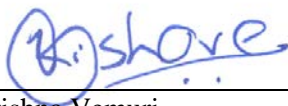
Prepared by:



Minh Ly

**Date:** August 02, 2019

Reviewed by:



Krishna Vemuri

**Date:** August 02, 2019

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Report No. 103985132MPK-002	
<b>Equipment Under Test:</b>	Philips Sonicare DiamondClean
<b>Trade Name:</b>	Philips Oral Healthcare LLC
<b>Model Tested:</b>	HX991B, HX991W
<b>Applicant:</b>	Philips Oral Healthcare LLC
<b>Contact:</b>	Matthew Vasa
<b>Address:</b>	Philips Oral Healthcare LLC 22100 Bothell Everett Highway Bothell, WA 98021
<b>Country:</b>	USA
<b>Tel. Number:</b>	(425) 482-8367
<b>Email:</b>	matthew.vasa@philips.com
<b>Applicable Regulation:</b>	FCC Part 15 Subpart C (15.247) Industry Canada RSS-247 Issue 2
<b>Date of Test:</b>	July 11 – 19, 2019

*We attest to the accuracy of this report:*



Minh Ly  
Project Engineer



Krishna K Vemuri  
Engineering Team Lead

## TABLE OF CONTENTS

<b>1.0</b>	<b>Summary of Tests .....</b>	<b>4</b>
<b>2.0</b>	<b>General Description .....</b>	<b>5</b>
2.1	Product Description .....	5
2.2	Related Submittal(s) Grants .....	6
2.3	Test Methodology .....	6
2.4	Test Facility .....	6
2.5	Measurement Uncertainty .....	6
<b>3.0</b>	<b>System Test Configuration .....</b>	<b>7</b>
3.1	Support Equipment and description .....	7
3.2	Block Diagram of Test Setup .....	7
3.3	Justification .....	8
3.4	Software Exercise Program .....	8
3.5	Mode of Operation during test .....	8
3.6	Modifications required for Compliance .....	8
3.7	Additions, deviations and exclusions from standards .....	8
<b>4.0</b>	<b>Measurement Results .....</b>	<b>9</b>
4.1	Field Strength of Fundamental and Radiated Emissions Outside the band .....	9
4.1.1	Requirements .....	9
4.1.2	Procedure .....	10
4.1.3	Test Results .....	11
4.2	Frequency Tolerance .....	18
4.2.1	Requirement .....	18
4.2.2	Procedure .....	18
4.2.3	Test Results .....	19
4.3	Occupied Bandwidth .....	20
4.3.1	Requirements .....	20
4.3.2	Procedure .....	20
4.3.3	Test Results .....	21
4.4	AC Line Conducted Emission .....	23
4.4.1	Requirement .....	23
4.4.2	Test Result .....	23
<b>5.0</b>	<b>List of test equipment .....</b>	<b>24</b>
<b>6.0</b>	<b>Document History .....</b>	<b>25</b>

## 1.0 Summary of Tests

TEST	REFERENCE FCC 15.225	REFERENCE RSS-210	RESULTS
Field Strength of Fundamental	15.225(a)	B.6	Complies
Radiated Emissions Outside the band	15.225(b), 15.225(c), 15.225(d), 15.209	B.6	Complies
Frequency Tolerance of the Carrier	15.225(e)	B.6	Complies
Line Conducted Emissions	15.207	RSS-GEN	Not Applicable <sup>2</sup>
Occupied Bandwidth	15.215	RSS-GEN	Complies
Antenna requirement	15.203	RSS-GEN	Complies <sup>1</sup>

<sup>1</sup> EUT utilizes an internal Antenna.

<sup>2</sup> EUT is battery operated.

## 2.0 General Description

### 2.1 Product Description

Philips Oral Healthcare LLC supplied the following description of the EUT:

The HX991B/ HX991W is a battery powered rechargeable toothbrush with Bluetooth and NFC.

#### Overview of the EUT

<b>Model</b>	HX991B, HX991W
<b>FCC Identifier</b>	2ADZNHX991
<b>IC Identifier</b>	20109-HX991
<b>Operating Frequency</b>	13.56MHz
<b>Number of Channels</b>	1
<b>Type of Modulation</b>	OOK
<b>Operating Temperature</b>	-20°C to +50°C
<b>Antenna Type</b>	Internal Loop Antenna
<b>Applicant name &amp; address</b>	Philips Oral Healthcare LLC 22100 Bothell Everett Highway Bothell, WA 98021

**EUT receive date:** July 11, 2019

**EUT receive condition:** The EUT was received in good condition with no apparent damage. As declared by the Applicant it is identical to the production units.

**Test start date:** July 11, 2019

**Test completion date:** July 19, 2019

## 2.2 Related Submittal(s) Grants

None

## 2.3 Test Methodology

Both AC mains line-conducted and radiated emissions measurements were performed according to the procedures in ANSI C63.4. Radiated tests were performed at an antenna to EUT distance of 10 meters, unless stated otherwise in this test report. All other measurements were made in accordance with the procedures in part 2 of CFR 47 7, ANSI C63.10: 2013, ANSI C63.4-2014 & RSS-GEN Issue 5.

## 2.4 Test Facility

The radiated emission test site and conducted measurement facility used to collect the data is 10m semi-anechoic chamber located in Menlo Park, California. This test facility and site measurement data have been fully placed on file with the FCC and Industry Canada (Site # 2042L-1).

## 2.5 Measurement Uncertainty

Compliance with the limits was based on the results of the measurements and doesn't take into account the measurement uncertainty.

Estimated Measurement Uncertainty

Measurement	Expanded Uncertainty (k=2)		
	0.15 MHz – 1 GHz	1 GHz – 2.5 GHz	> 2.5 GHz
RF Power and Power Density – antenna conducted	-	0.7 dB	-
Unwanted emissions - antenna conducted	1.1 dB	1.3 dB	1.9 dB
Bandwidth – antenna conducted	-	30 Hz	-

Measurement	Expanded Uncertainty (k=2)		
	0.15 MHz – 30MHz	30 MHz – 1 GHz	1 GHz – 18 GHz
Radiated emissions	-	4.7	5.1 dB
AC mains conducted emissions	2.1 dB	-	-

### 3.0 System Test Configuration

#### 3.1 Support Equipment and description

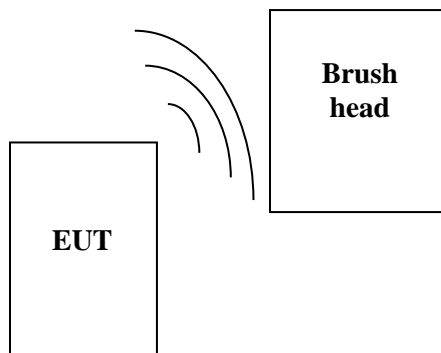
None

#### 3.2 Block Diagram of Test Setup

Equipment Under Test			
Description	Manufacturer	Model	Serial Number
Radiated Spurious Sample	Philips Oral Healthcare LLC.	HX991B	Not listed

#### 3.2 Block Diagram of Test Setup (Continued)

##### Battery Mode:



<b>S</b> = Shielded	<b>F</b> = With Ferrite
<b>U</b> = Unshielded	<b>m</b> = Length in Meters

### 3.3 Justification

For radiated emission measurements the EUT is placed on a non-conductive table. The EUT was configured to continuously transmit and looking for tags. The highest clock frequency used in the EUT is less than 2.5 GHz.

Per manufacture, model HX991B (Black) and HX991W (White) are identical in hardware and material except for the different color.

### 3.4 Software Exercise Program

The EUT exercise program used during testing was provided by Philips Oral Healthcare LLC.

### 3.5 Mode of Operation during test

The EUT was constantly broadcasting a 13.56 MHz signal while reading an RFID tag

### 3.6 Modifications required for Compliance

No Modifications were made e to bring the EUT into compliance.

### 3.7 Additions, deviations and exclusions from standards

No additions, deviations or exclusion have been made from standard.



## 4.0 Measurement Results

### 4.1 Field Strength of Fundamental and Radiated Emissions Outside the band

#### 4.1.1 Requirements

FCC Rules 15.225, 15.209

- a) The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter (84 dBuV) at 30 meters.
- b) Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.
- c) Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.
- d) The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in §15.209.

§15.209 Radiated emission limits; general requirements.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

#### 4.1.2 Procedure

##### Radiated Measurements Below 30 MHz

During the test the EUT is rotated and the measuring antenna angles are varied during the search for maximum signal level.

Radiated emissions are taken at ten meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. Measurements for below 30 MHz were performed at 10 meters. Data results below are corrected for distance at 10m. Limits were normalized to 10 meters.

##### Radiated Measurements Above 30 MHz

During the test the EUT is rotated and the measuring antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters.

Radiated emissions are taken at ten meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. Measurements for above 30 MHz were made at 10 meters.

Radiated emission measurements were performed from 9kHz to 1 GHz.  
Analyzer resolution is:

200Hz or greater for 9kHz to 150kHz  
9 kHz or greater for 150kHz to 30 MHz  
120 kHz or greater for 30MHz to 1000 MHz  
For those frequencies quasi-peak detector applies

Data includes of the worst-case configuration (the configuration which resulted in the highest emission levels). A sample calculation, configuration photographs and data tables of the emissions are included.

##### Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation is as follows:

$$FS = RA + AF + CF - AG - DCF$$

Where FS = Field Strength in dB ( $\mu$ V/m)

RA = Receiver Amplitude (including preamplifier) in dB ( $\mu$ V)

CF = Cable Attenuation Factor in dB

AF = Antenna Factor in dB (1/m)

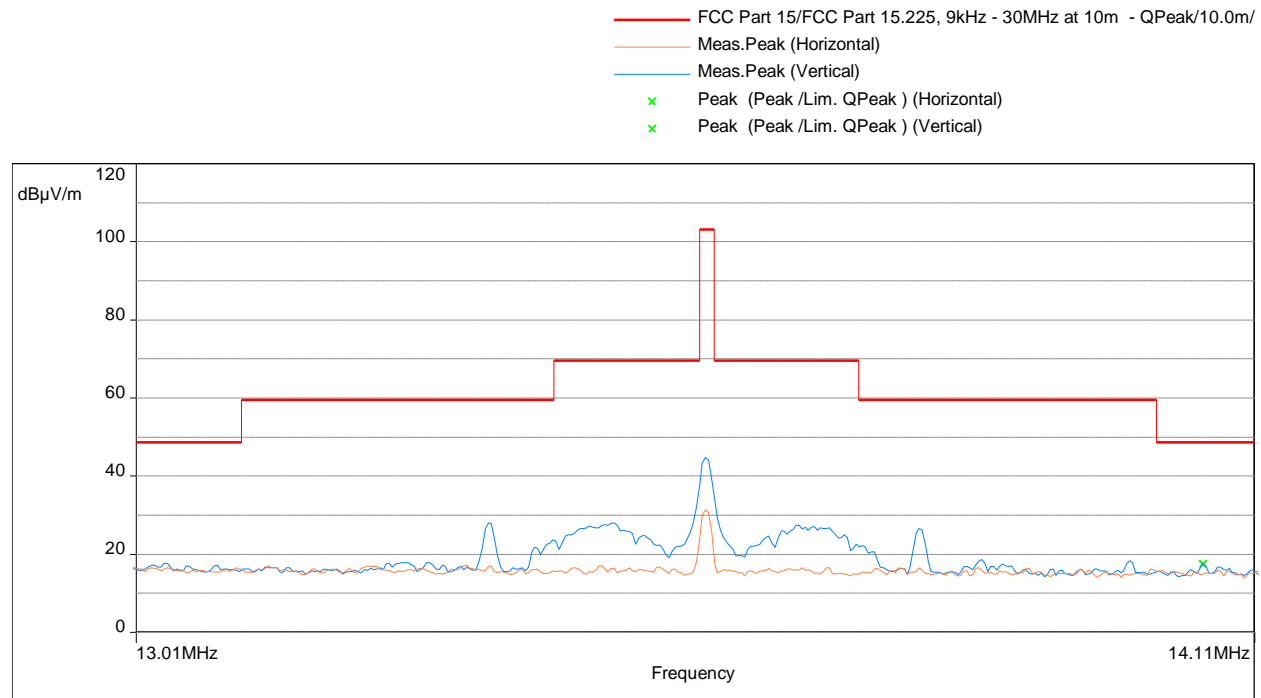
AG = Amplifier Gain in dB

DCF = Distance Correction Factor

Note: FS was measured with loop antenna below 30MHz

#### 4.1.3 Test Results

The data below shows the significant emission frequencies, the limit and the margin of compliance.  
Note: Measurements were performed at parallel and perpendicular orientation of loop antenna, and vertical and horizontal orientations of EUT. The worst-case data was presented below.

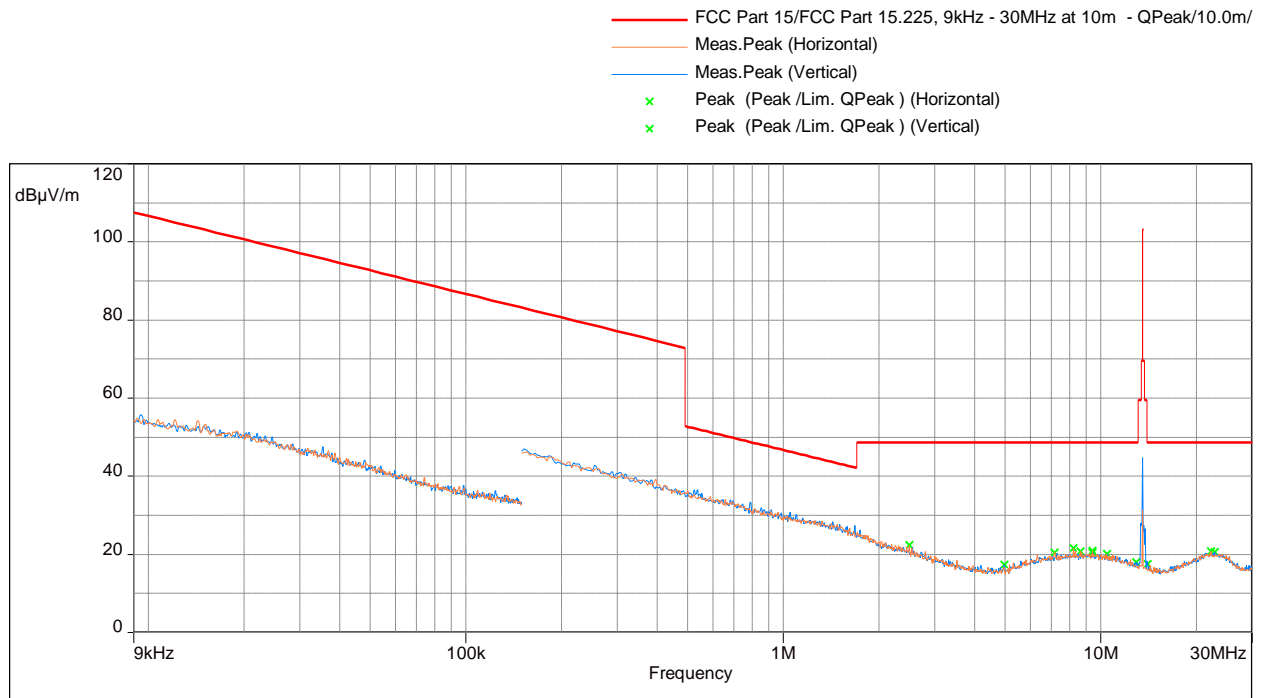


Frequency	Corrected Peak FS @10m	Limit @10m	Margin	RA@10m	Correction
(MHz)	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB
13.56	44.78	103.1	-58.3	41.5	3.3

Note: Correction = AF+CF-AG

#### 4.1.3 Test Result (Continued)

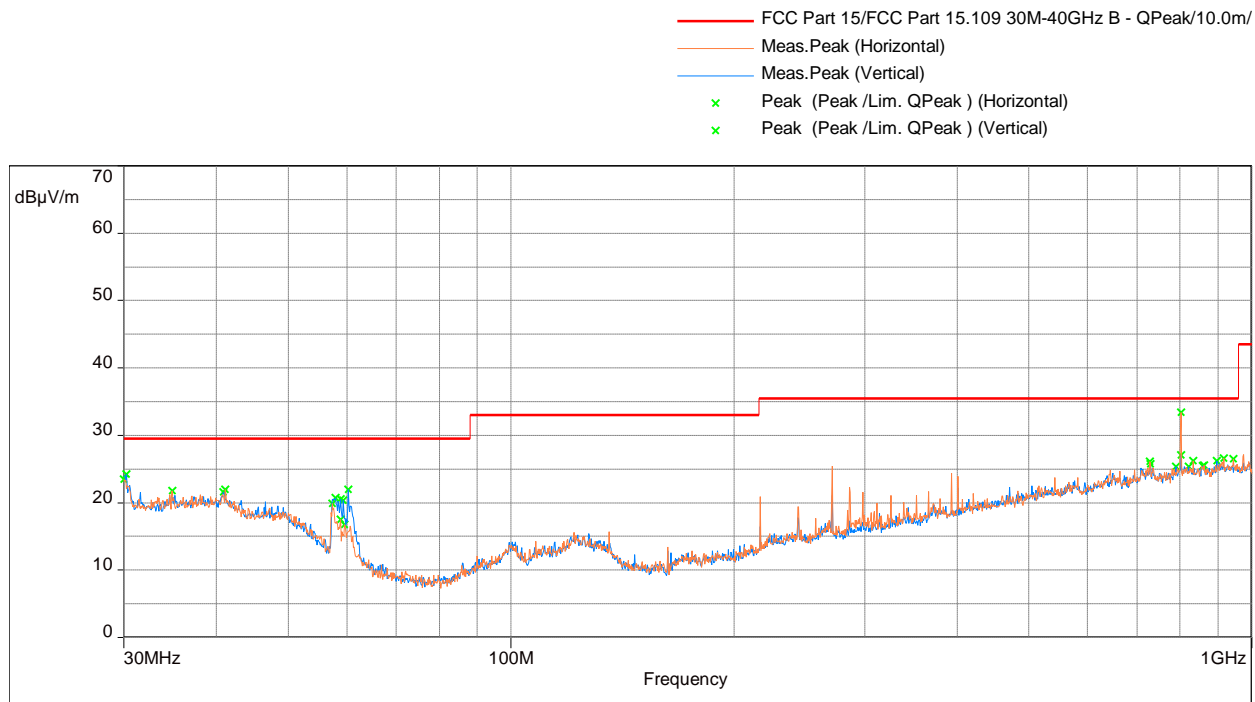
##### *Radiated Spurious Emissions from 9 kHz to 30MHz*



Model: ; Client: ; Comments: ; Test Date: 07/17/2019 18:48

#### 4.1.3 Test Result (Continued)

##### *Radiated Spurious Emissions from 30 MHz to 1000 MHz*

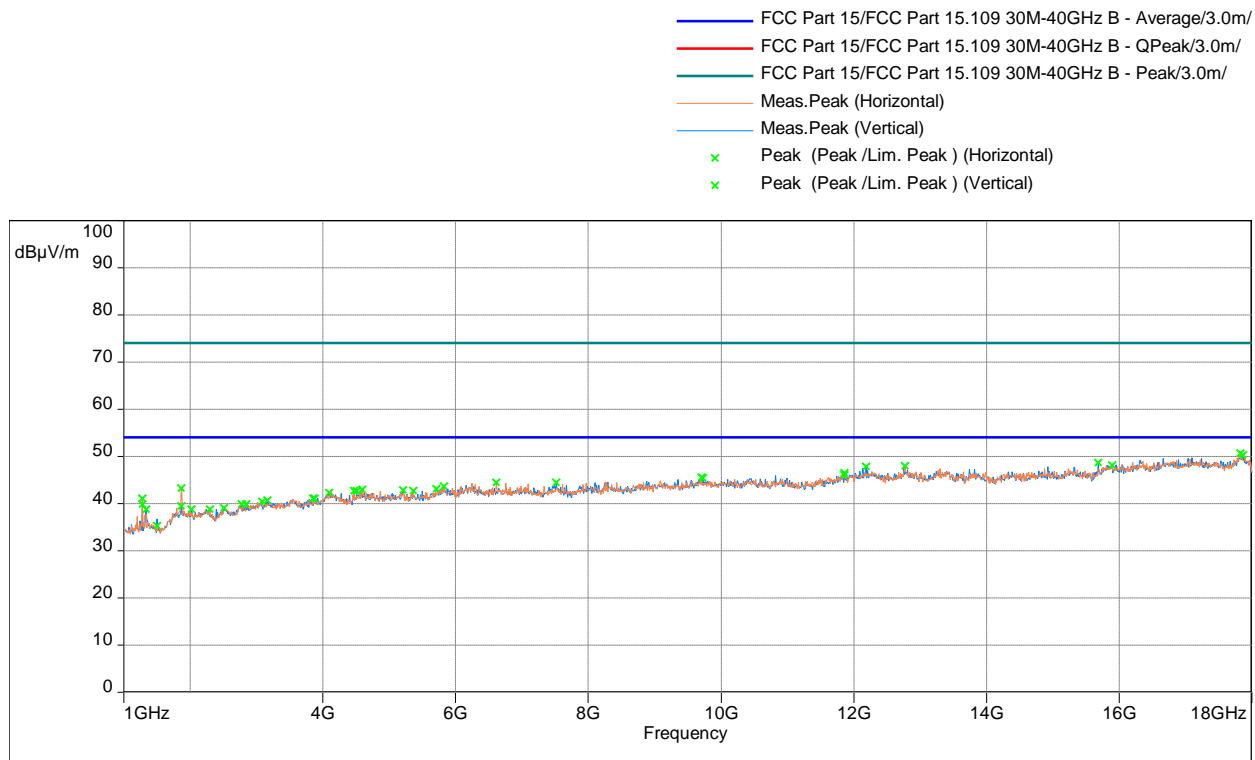


Model: ; Client: ; Comments: ; Test Date: 07/18/2019 19:07

Frequency (MHz)	Peak (dBμV/m) @10m	Lim. QPeak (dBμV/m) @10m	Margin (dB)	Height (m)	Angle (°)	Polarity	Correction (dB)
30.259	24.2	29.5	-5.3	4.0	264.5	Vertical	-6.7
40.896	21.5	29.5	-8.0	1.0	211.3	Vertical	-6.7
57.904	20.7	29.5	-8.8	4.0	159.3	Vertical	-14.5
59.326	20.3	29.5	-9.2	4.0	48.5	Vertical	-15.1
271.174	25.4	35.5	-10.1	4.0	300.0	Horizontal	-10.4
801.829	33.4	35.5	-2.1	1.0	44.5	Horizontal	-1.6
801.829	27.1	35.5	-8.4	2.0	359.8	Vertical	-1.6

#### 4.1.3 Test Result (Continued)

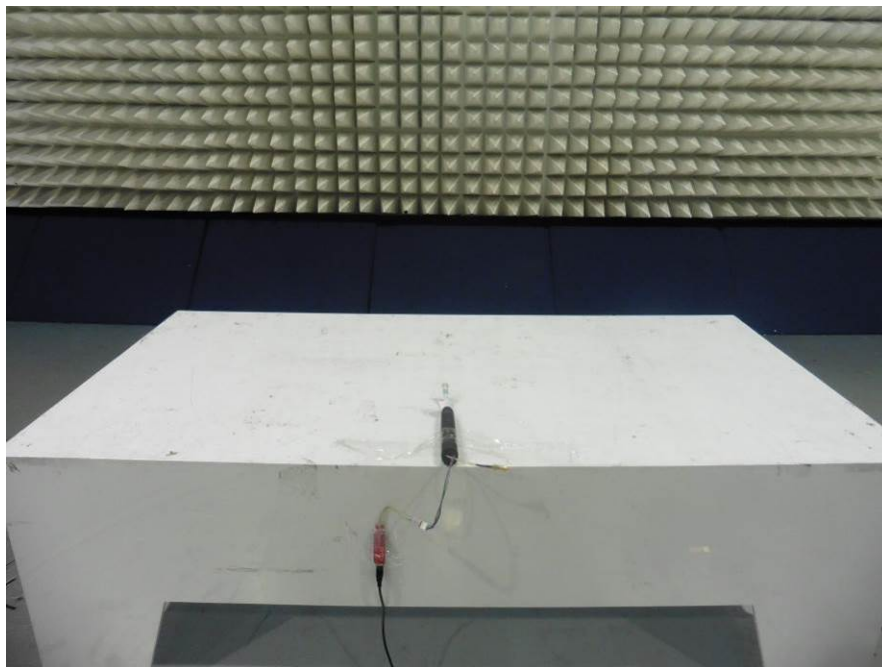
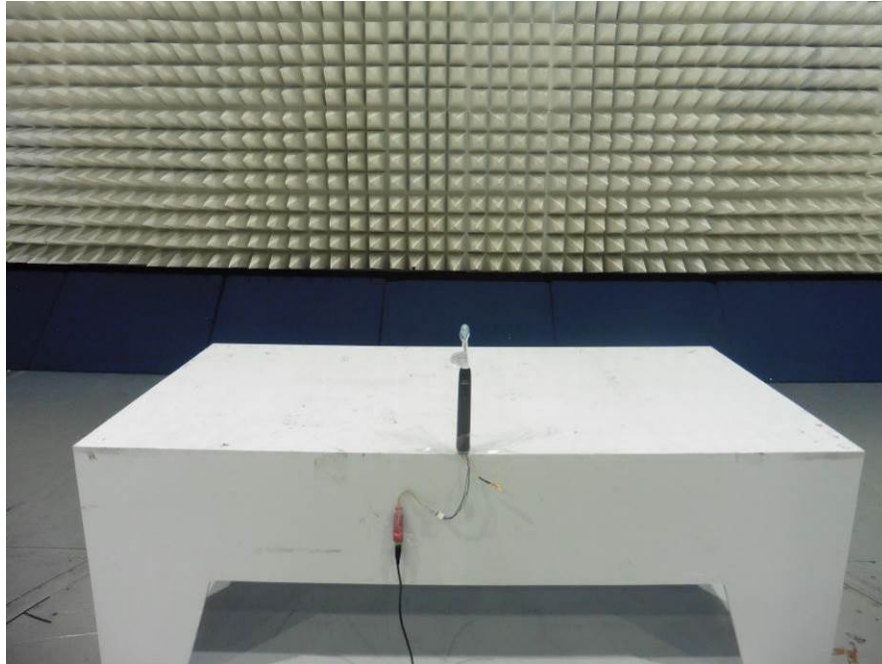
##### *Radiated Spurious Emissions from 1GHz to 18 GHz, Peak Scan*



Model: ; Client: ; Comments: ; Test Date: 07/16/2019 17:16

#### 4.1.4 Test Configuration Photographs

**The following photographs show the testing configurations used.**



*Electromagnetic Radiated Disturbance Setup Photograph*

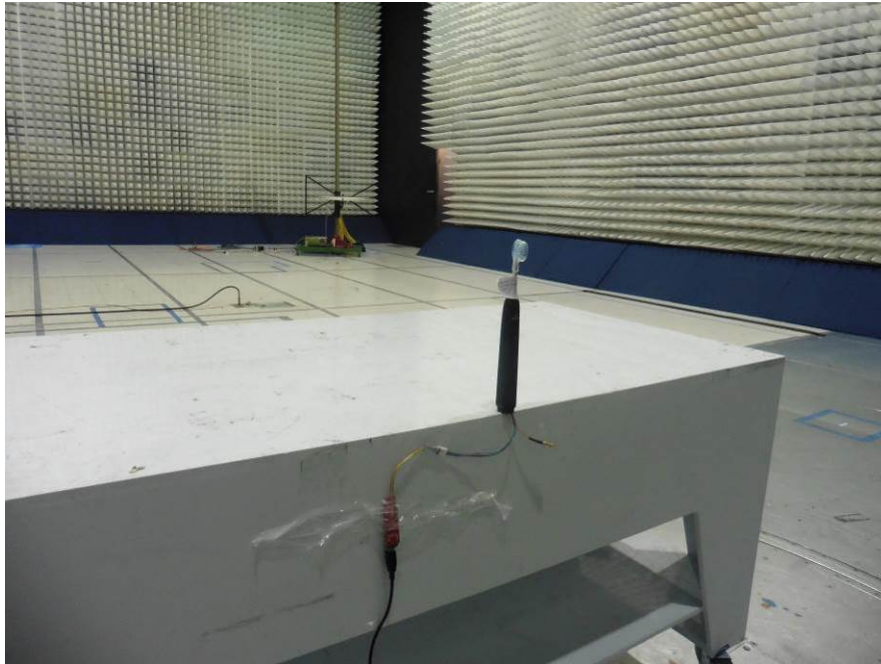


#### 4.1.5 Test Configuration Photographs (Continued)





#### 4.1.5 Test Configuration Photographs (Continued)



## 4.2 Frequency Tolerance

### 4.2.1 Requirement FCC 15.225 (e)

The frequency tolerance of the carrier signal shall be maintained within  $\pm 0.01\%$  of the operating frequency over a temperature variation of  $-20$  degrees to  $+50$  degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

### 4.2.2 Procedure

The EUT was placed in the temperature chamber. The frequency counter was connected to the transmitter output. For each temperature, the carrier frequency was recorded.

#### 4.2.3 Test Results

Battery Voltage (DC)	Temperature (C)	Measured Frequency (Hz)	Deviation from Reference (Hz)	Deviation (%)
3.7	50	13559038	-160	-0.00118
3.7	40	13559118	-80	-0.00059
3.7	30	13559198	0	0.00000
3.7	20	13559198	0	0.00000
3.7	10	13559278	80	0.00059
3.7	0	13559282	84	0.00062
3.7	-10	13559278	80	0.00059
3.7	-20	13559294	96	0.00071
3.7 with Fully Charged Battery	20	13559358	160	0.00118

Nominal Frequency @ 20C, 3.7VDC: 13559198 Hz

#### 4.3 Occupied Bandwidth FCC 15.215

##### 4.3.1 Requirements

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage.

##### 4.3.2 Procedure

The EUT was setup to transmit in normal operating condition.

Measurements were made with the loop antenna in close proximity of the EUT. Following the procedures of ANSI 63.10, the 20dB bandwidth measurements were taken. The following plots show Occupied Bandwidth.

### 4.3.3 Test Results

Frequency (MHz)	20-dB Channel Bandwidth (kHz)	99% Channel Bandwidth (kHz)
13.56	424.7	568.9

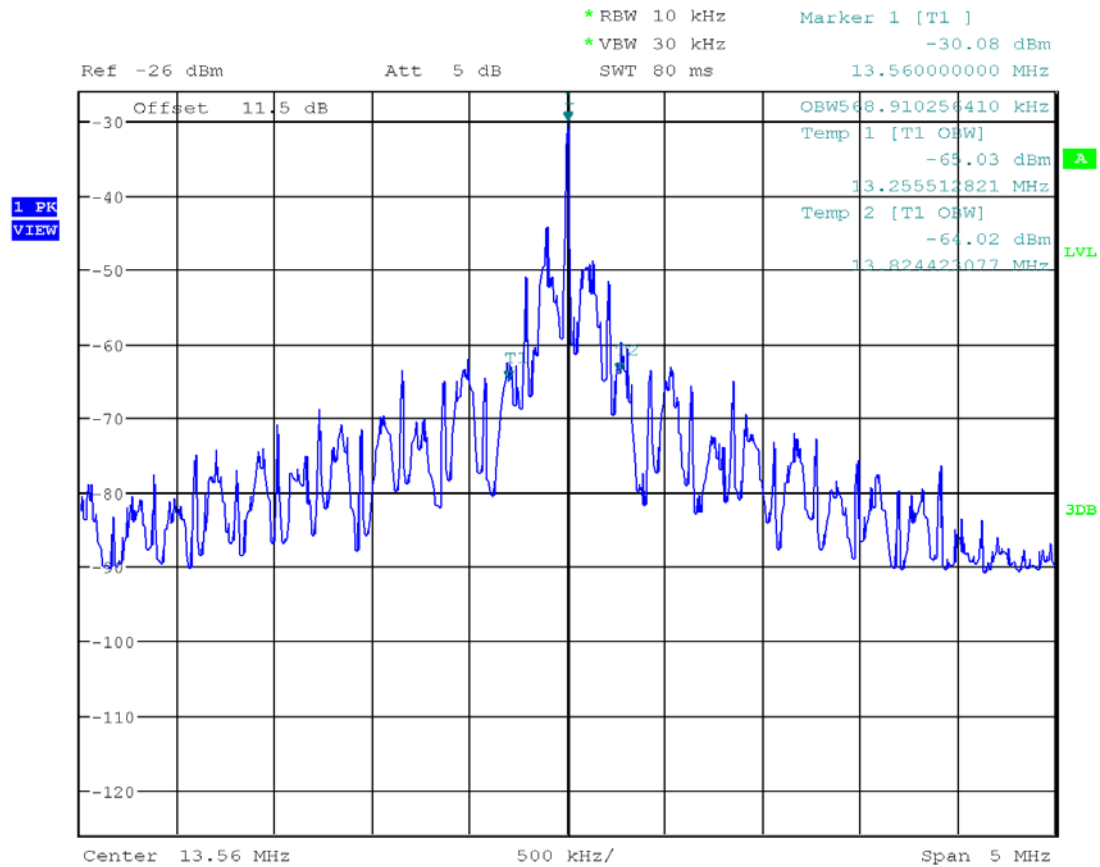
### 20-dB Channel Bandwidth



Date: 15.JUL.2019 16:30:06

## 4.3.3 Test Results (Continued)

### 99% Channel Bandwidth



Date: 15.JUL.2019 16:16:34

#### 4.4 AC Line Conducted Emission FCC Rule 15.207

##### 4.4.1 Requirement

Frequency Band MHz	15.207 Limit dB(μV)	
	Quasi-Peak	Average
0.15-0.50	66 to 56 *	56 to 46 *
0.50-5.00	56	46
5.00-30.00	60	50

*Note: \*Decreases linearly with the logarithm of the frequency. At the transition frequency the lower limit applies.*

##### 4.4.2 Test Result

Not Applicable. EUT is battery operated.

## 5.0 List of test equipment

Measurement equipment used for emission compliance testing utilized the equipment on the following list:

Equipment	Manufacturer	Model/Type	Asset No.	Calibration Interval	Cal Due
Bi-Log Antenna	Antenna Research	LPB-2513/A	ITS 00355	12	04/24/20
Pre-Amplifier	Sonoma Instrument	310N	ITS 00415	12	04/19/20
Horn Antenna	ETS Lindgren	3117-PA	ITS 01636	12	01/17/20
EMI Receiver	Rohde and Schwarz	ESR7	ITS 01607	12	10/23/19
RF Cable	TRU Corporation	TRU CORE 300	ITS 01330	12	05/09/20
RF Cable	TRU Corporation	TRU CORE 300	ITS 00465	12	08/16/19
RF Cable	TRU Corporation	TRU CORE 300	ITS 01470	12	08/16/19
Loop Sensor	Solar Electronics	7334-1	ITS 01608	12	10/09/19
Environmental Test Chamber	ESPEC	BTX-475	ITS 01436	12	09/21/19
Ant-Passive Loop	EMCO	6512	ITS 01598	12	10/09/19

# Verified before use

Software used for emission compliance testing utilized the following:

Name	Manufacturer	Version	Template/Profile
BAT-EMC	Nexio	3.17.0.10	Philips, ML_07-2019.bpp



**6.0 Document History**

Revision/ Job Number	Writer Initials	Reviewer Initials	Date	Change
1.0 / G103985132	ML	KV	August 02, 2019	Original document

***END OF REPORT***