

TEST REPORT

Report Number: 104498238MPK-002

Project Number: G104498238

March 03, 2021

Testing performed on the
Rechargeable Electric Toothbrush Handle
Model Number: HX999C

FCC ID: 2ADZNHX999

IC: 20109-HX999

to

FCC Part 15 Subpart C (15.225)
ISED RSS-210 Issue 10

For

Philips Oral Healthcare LLC

Test Performed by:

Intertek
1365 Adams Court
Menlo Park, CA 94025 USA

Test Authorized by:

Philips Oral Healthcare LLC
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Bothell, WA 98021 USA

Prepared by:



Anderson Soungpanya

Date: March 03, 2021

Reviewed by:



Krishna Vemuri

Date: March 03, 2021

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Report No. 104498238MPK-002	
Equipment Under Test:	Rechargeable Electric Toothbrush Handle
Model Number:	HX999C
Applicant:	Philips Oral Healthcare LLC
Contact:	Cathy Burton
Address:	Philips Oral Healthcare LLC 22100 Bothell Everett Highway Bothell, WA 98021
Country:	USA
Tel. Number:	(425) 487-7000
Email:	cathy.burton@philips.com
Applicable Regulation:	FCC Part 15 Subpart C (15.225) ISED RSS-210 Issue 10
Date of Test:	December 01, 2020 to January 26, 2021

We attest to the accuracy of this report:



Anderson Soungpanya
Project Engineer



Krishna K Vemuri
EMC Manager

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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 – RFID is disabled while charging
Occupied Bandwidth	15.215	RSS-GEN	Complies
Antenna requirement	15.203	RSS-GEN	Complies ¹

¹ The EUT utilizes an internal Antenna.

2.0 General Description

2.1 Product Description

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

The Philips HX999C is a rechargeable electric toothbrush that is inductively charged. Bluetooth connectivity allows the toothbrush to be connected to an app which provides real-time guidance on pressure, motion, position, duration and frequency of brushing. The toothbrush also tracks the brush head usage through RFID to alert the user when the heads need to be replaced.

Overview of the EUT

Applicant name & address	Philips Oral Healthcare LLC 22100 Bothell Everett Highway Bothell, WA 98021 USA
Contact info / Email	Cathy Burton / cathy.burton@philips.com
Model	HX999C
FCC Identifier	2ADZNHX999
IC Identifier	20109-HX999
Operating Frequency	13.56 MHz
Number of Channels	1
Type of Modulation	ASK Modulation
Antenna Type	Internal Antenna

EUT receive date: November 20, 2020

EUT receive condition: The pre-production version of 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: December 01, 2020

Test completion date: January 26, 2020

2.2 Related Submittal(s) Grants

None

2.3 Test Methodology

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, RSS-210 Issue 10 & 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

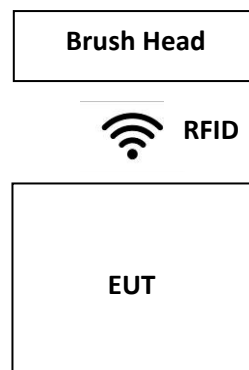
Support Equipment		
Description	Manufacturer	Model
Brush Head	Philips Oral Healthcare LLC	C3

Equipment Under Test			
Description	Manufacturer	Model	Serial Number
Rechargeable Electric Toothbrush Handle	Philips Oral Healthcare LLC	HX999C	EB5-193

The EUT is powered by 3.8 VDC (internal battery).

3.2 Block Diagram of Test Setup

The diagram shown below details the interconnection of the EUT and support equipment. For specific layout, refer to the test configuration photograph in the relevant section of this report.



S = Shielded	F = With Ferrite
U = Unshielded	m = 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.

Per manufacturer, Toothbrush Handle, model HX999x (x= letter from A to Z for cosmetic differences)

3.4 Software Exercise Program

None

3.5 Mode of Operation during test

The Rechargeable Electric Toothbrush Handle s was set up to continuously transmitting at 13.56MHz.

3.6 Modifications required for Compliance

No modifications were made by the manufacturer 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

- 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	$2400/F(\text{kHz})$	300
0.490-1.705	$24000/F(\text{kHz})$	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 made at 10 meters. Data results below are corrected for distance back to 30 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 ($\mu V/m$)

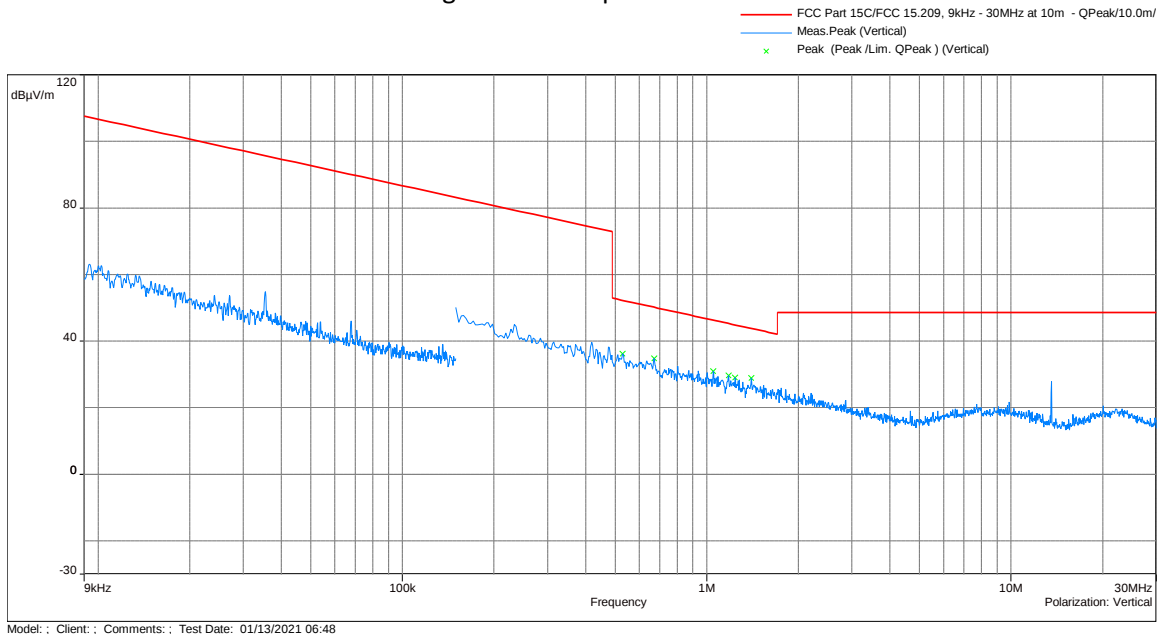
RA = Receiver Amplitude (including preamplifier) in dB (μV)
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB (1/m)
AG = Amplifier Gain in dB
DCF = Distance Correction Factor

Note: FS was measured with loop antenna below 30MHz

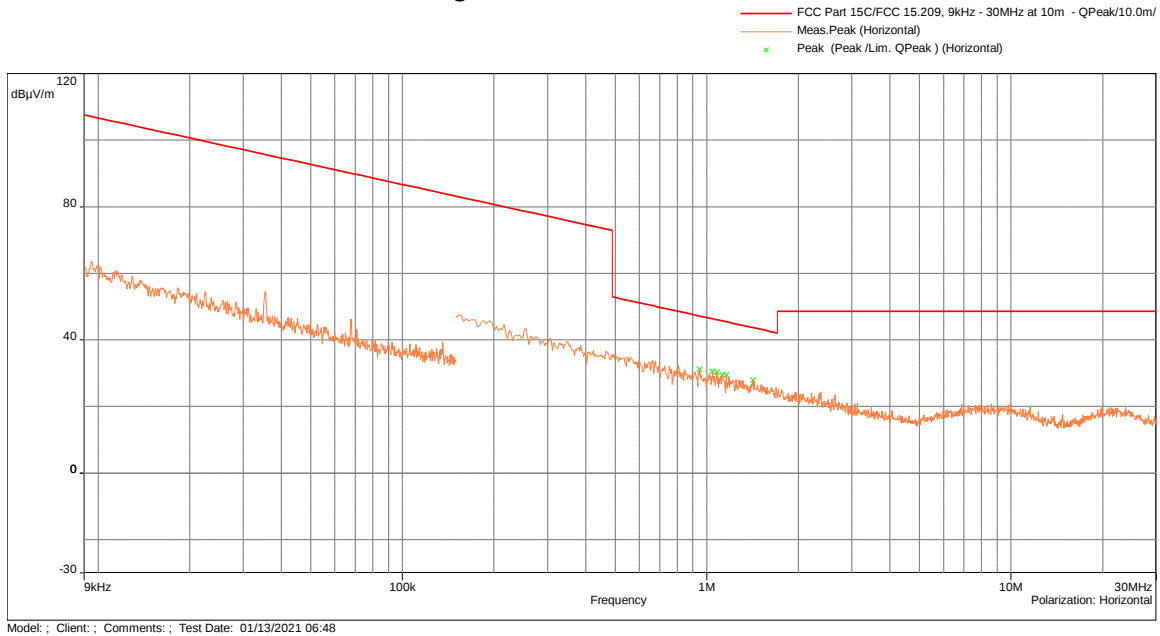
4.1.3 Test Result 15.225 (a) (b) (c) (d) and 15.209

Radiated Spurious Emissions from 9 kHz to 30MHz, EUT Upright (X-Axis)

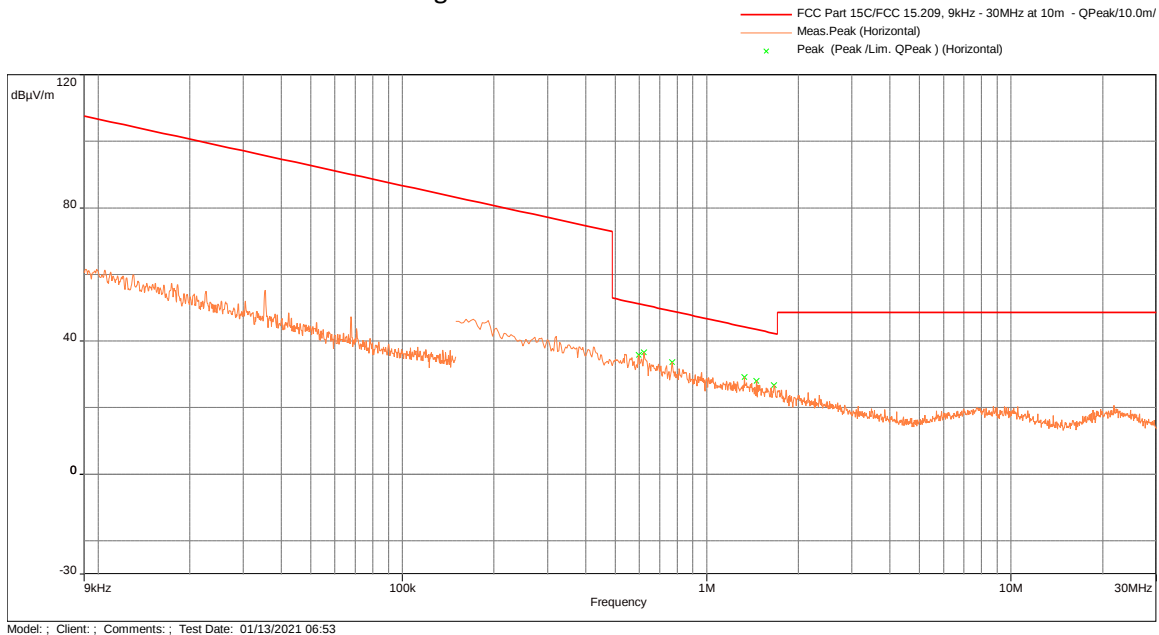
Receiving Antenna Coplanar Orientation



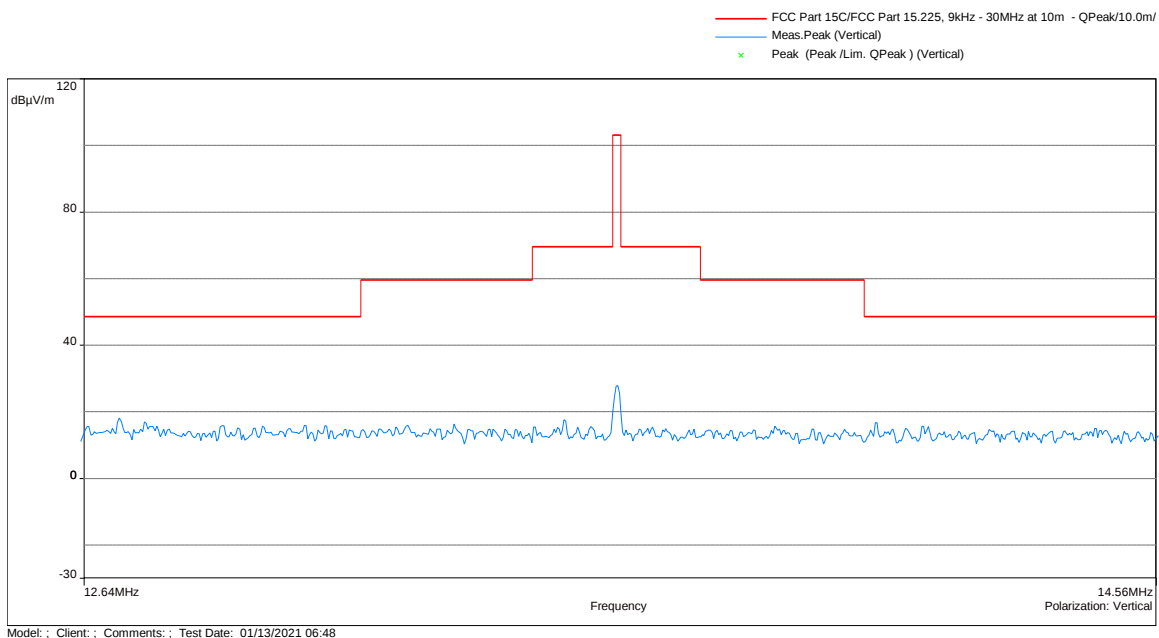
Receiving Antenna Coaxial Orientation



Receiving Antenna Horizontal Orientation



Test Result 15.225 (a)(b)(c) Radiated Spurious Emissions Mask

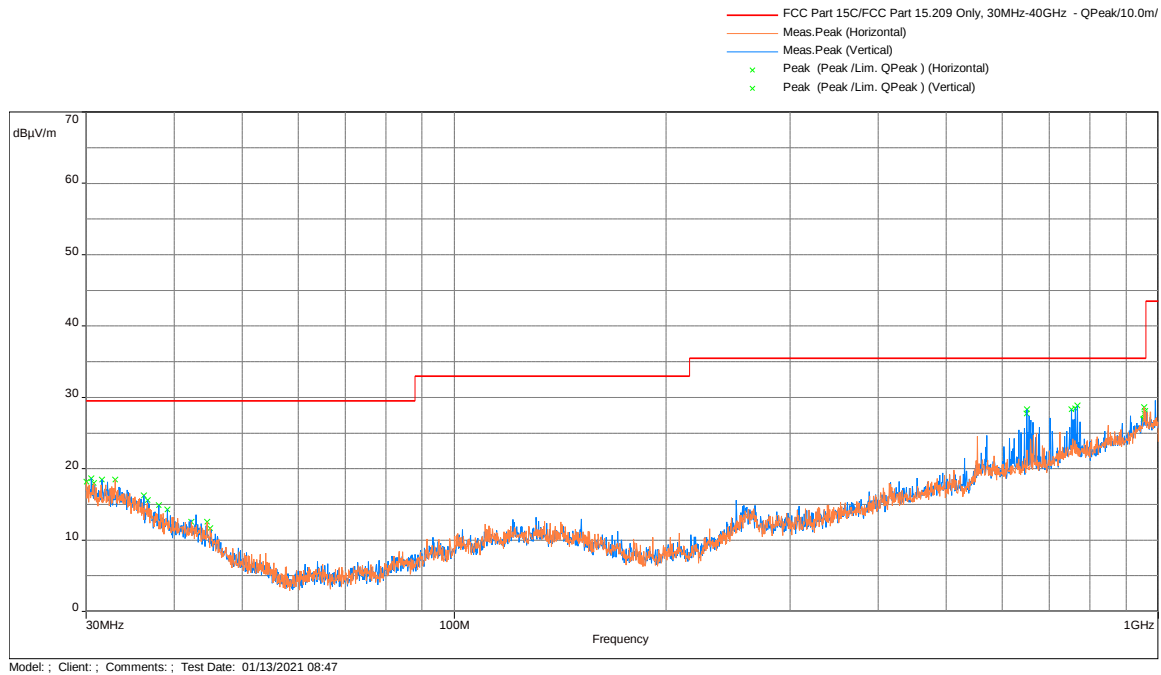


Frequency (MHz)	Peak FS@10m dB(µV/m)	Limit@10m dB(µV/m)	Margin dB	Comment	Correction dB
13.56	27.9	103.1	-75.2	Coplanar	2.89

Note: Correction = AF+CF-AG- distance correction factor

Distance correction factor=40*log₁₀(limit distance/measured distance)

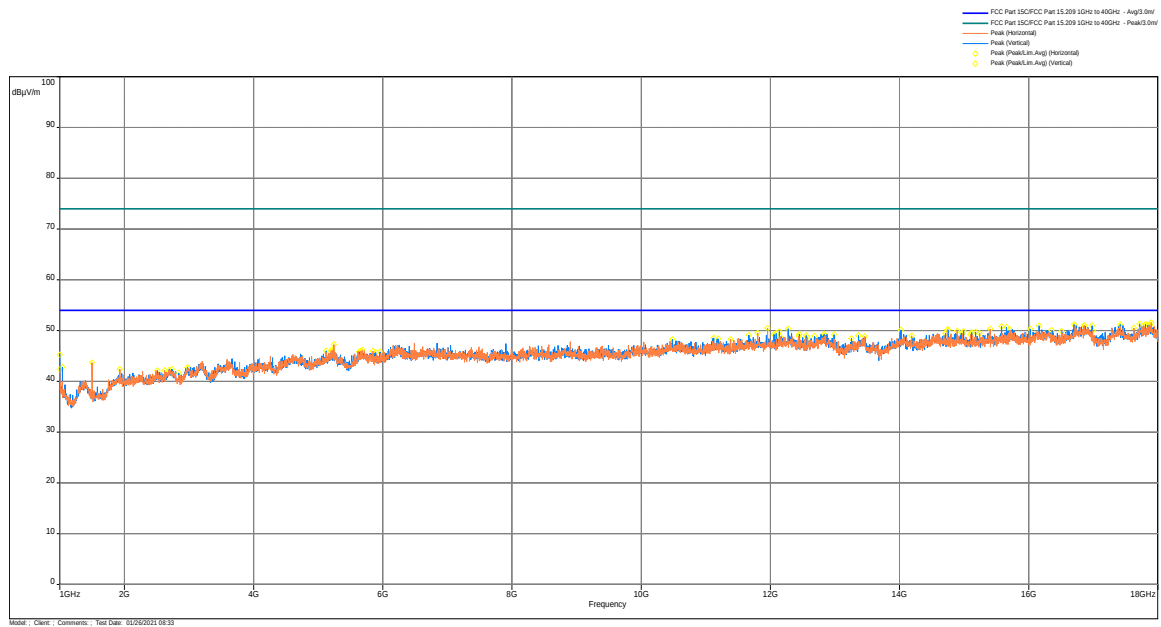
Radiated Spurious Emissions from 30 to 1000 MHz



Freq (MHz)	Peak FS @10m dB(uV/m)	Limit @10m dB(uV/m)	Margin (dB)	Height (m)	Azimuth (Deg)	Polarity	Correction (dB)
649.927	27.72	35.5	-7.78	1.98	23	Vertical	-5.06
651.188	28.32	35.5	-7.18	1.98	186	Vertical	-5.05
753.361	28.30	35.5	-7.20	1.98	0	Vertical	-2.81
762.059	28.44	35.5	-7.06	1.98	59	Vertical	-2.75
767.782	28.85	35.5	-6.65	1.00	118	Vertical	-2.77
956.447	27.7	35.5	-7.80	1.98	177	Vertical	1.92

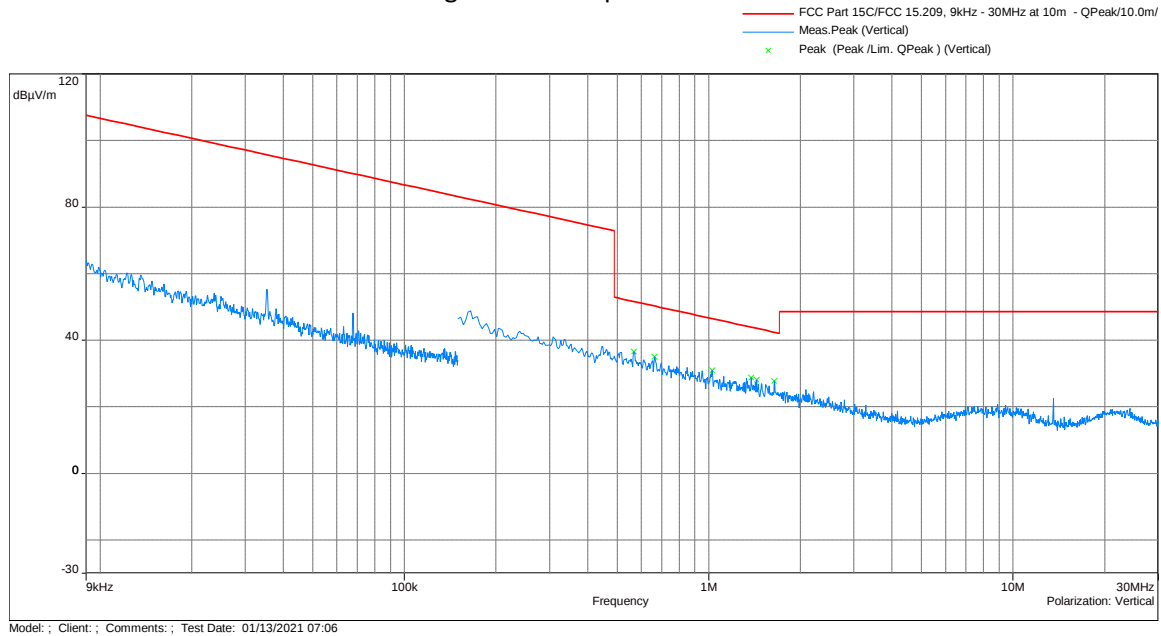
Note: Correction = AF + CF –AG

Radiated Spurious Emissions from 1 to 18 GHz, Peak Scan vs Avg and Peak Limits

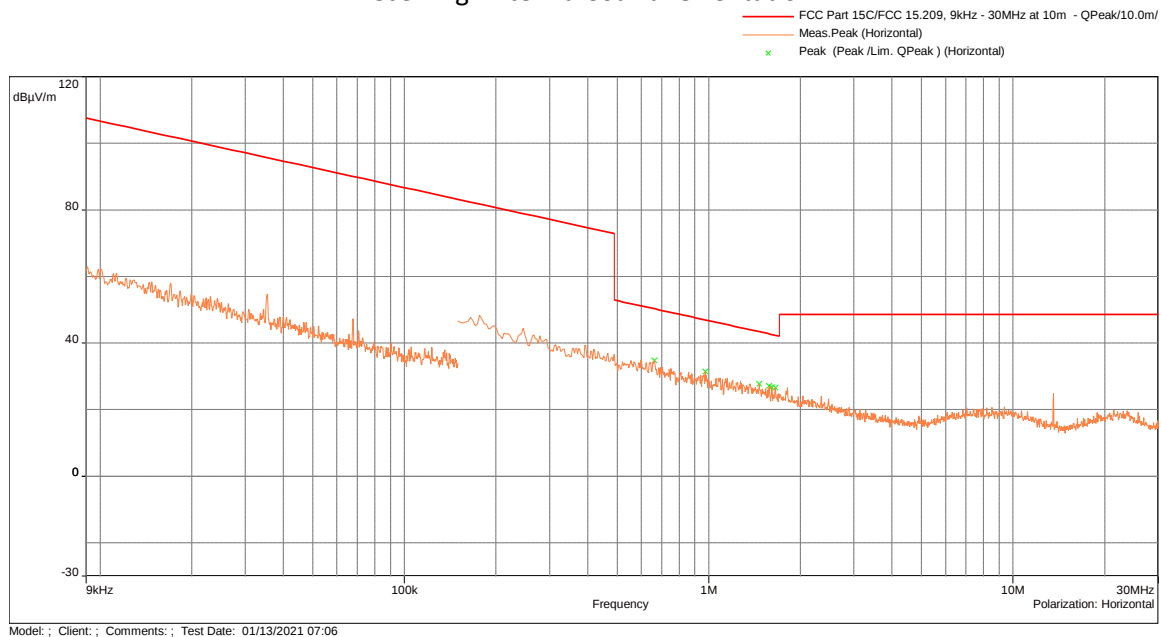


Radiated Spurious Emissions from 9 kHz to 30MHz, EUT Flat on Back (Y-Axis)

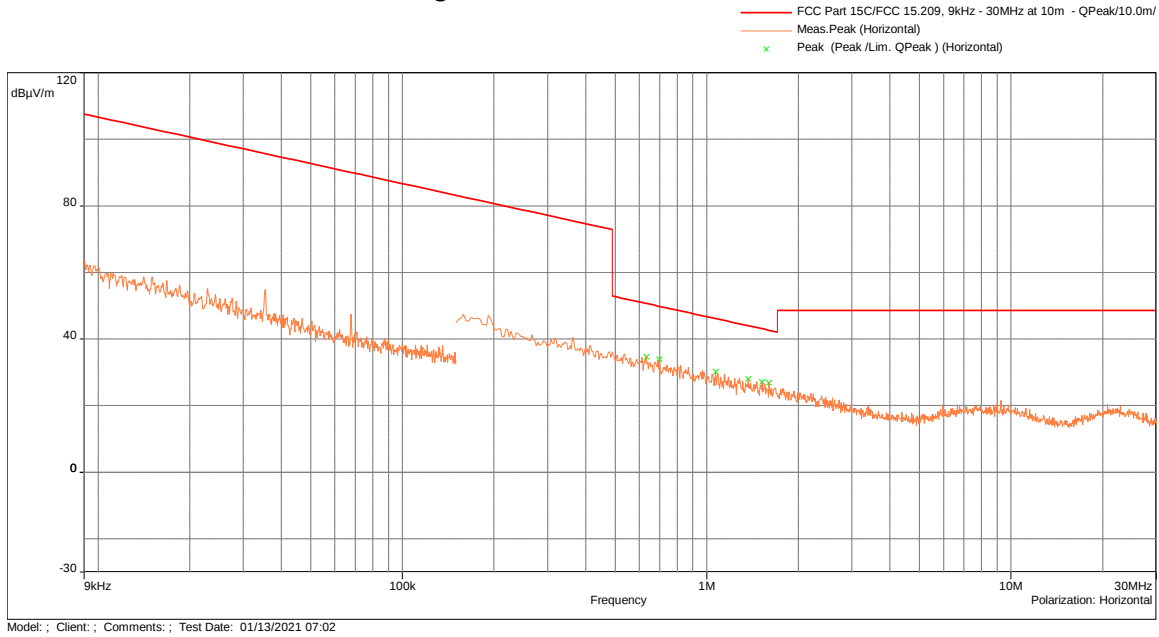
Receiving Antenna Coplanar Orientation



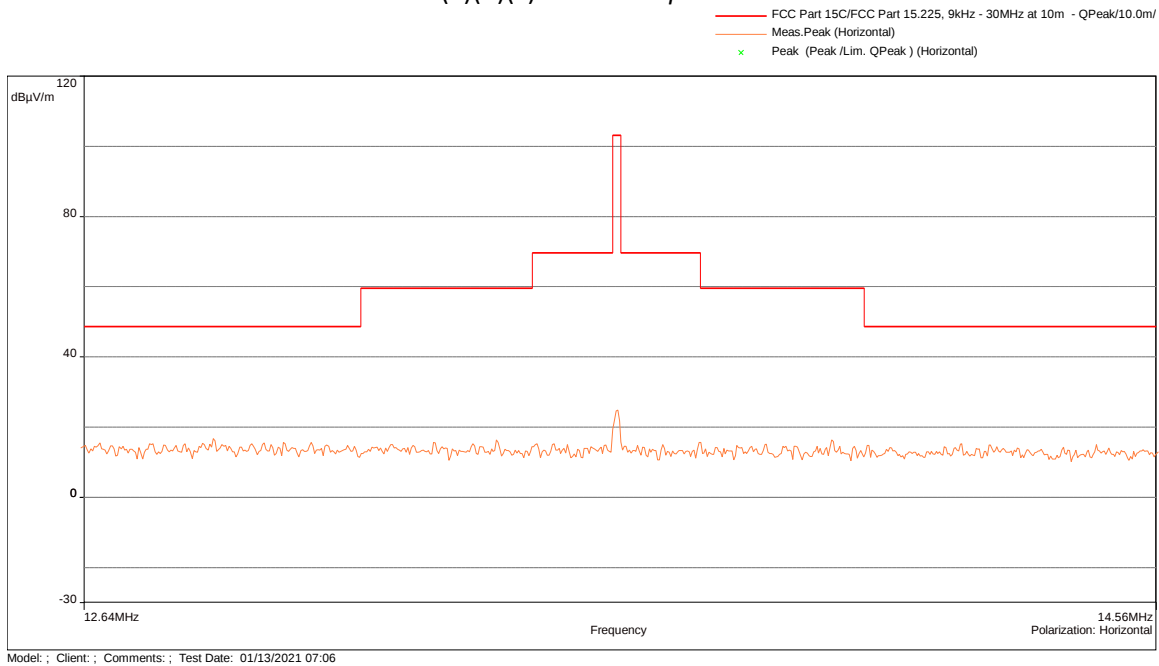
Receiving Antenna Coaxial Orientation



Receiving Antenna Horizontal Orientation



Test Result 15.225 (a)(b)(c) Radiated Spurious Emissions Mask

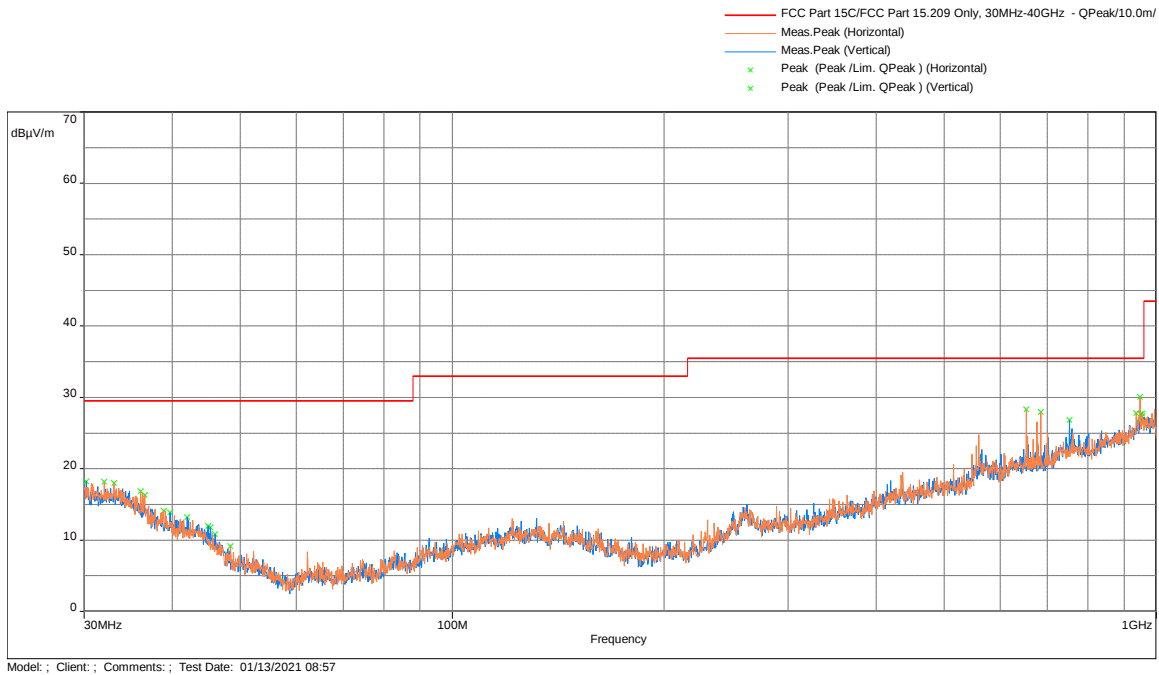


Frequency (MHz)	Peak FS@10m dB(μV/m)	Limit@10m dB(μV/m)	Margin dB	Comment	Correction dB
13.56	24.9	103.1	78.2	Coaxial	2.89

Note: Correction = AF+CF-AG- distance correction factor

Distance correction factor= $40 \cdot \log_{10}(\text{limit distance}/\text{measured distance})$

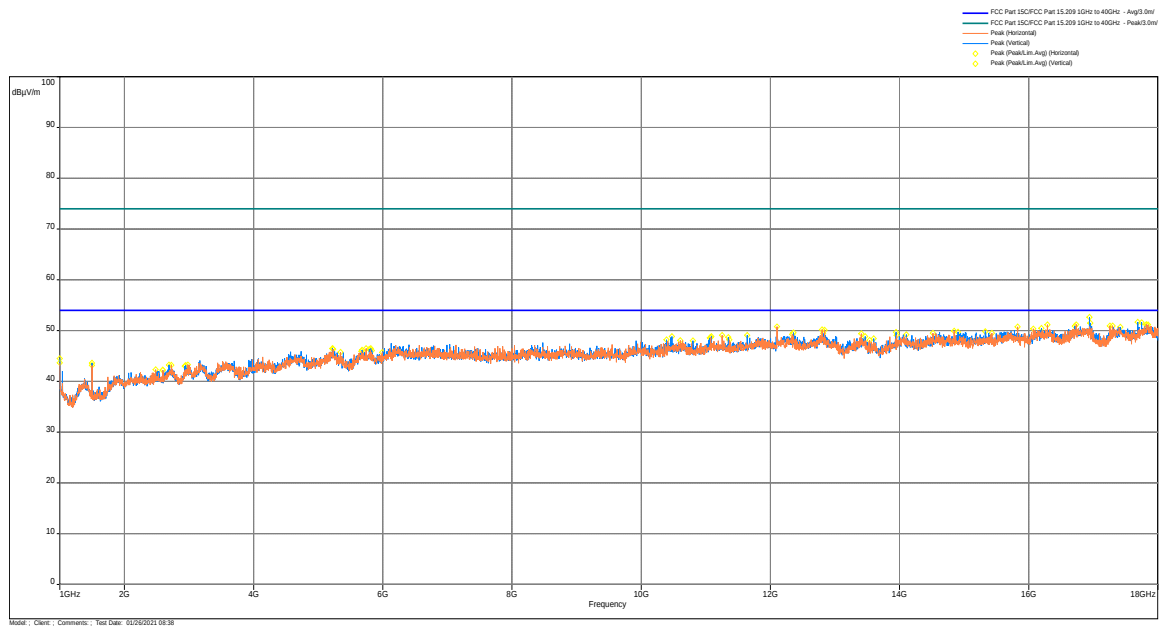
Radiated Spurious Emissions from 30 to 1000 MHz



Freq (MHz)	Peak FS @10m dB(μV/m)	Limit @10m dB(μV/m)	Margin (dB)	Height (m)	Azimuth (Deg)	Polarity	Correction (dB)
653.839	28.34	35.5	-7.16	2.00	336	Horizontal	-5.04
685.297	27.96	35.5	-7.54	2.00	173	Horizontal	-4.88
948.331	30.02	35.5	-5.48	2.00	326	Horizontal	1.65
753.199	26.8	35.5	-8.70	1.00	158	Vertical	-2.81
943.255	26.7	35.5	-8.80	1.00	267	Vertical	1.27
950.303	27.67	35.5	-7.83	1.98	257	Vertical	1.74

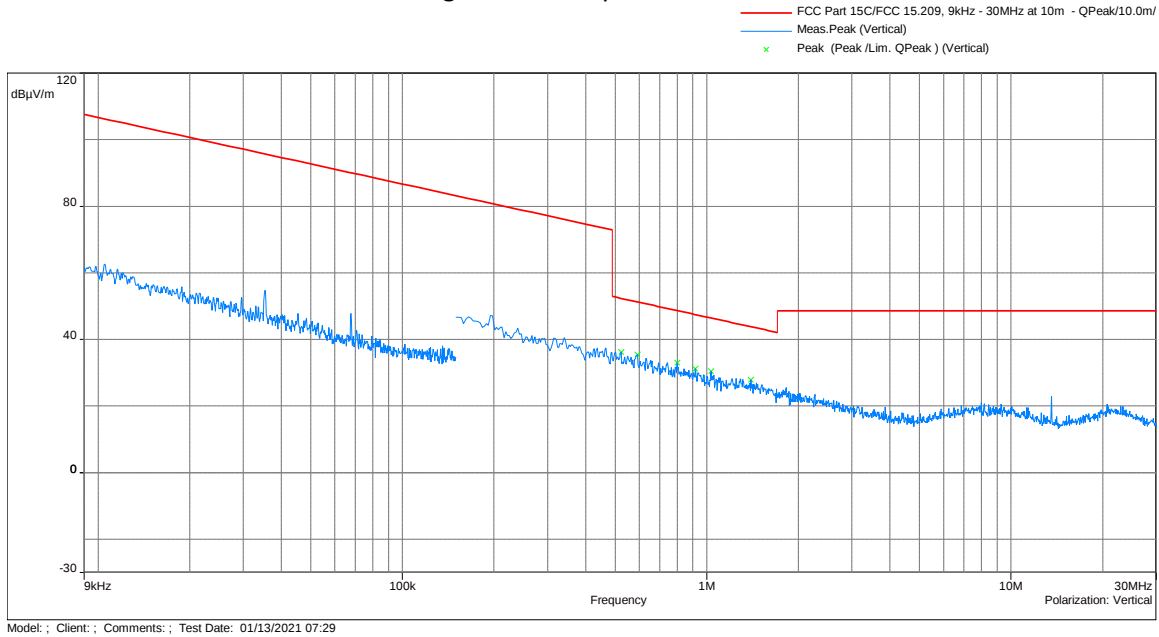
Note: Correction = AF + CF –AG

Radiated Spurious Emissions from 1 to 18 GHz, Peak Scan vs Avg and Peak Limits

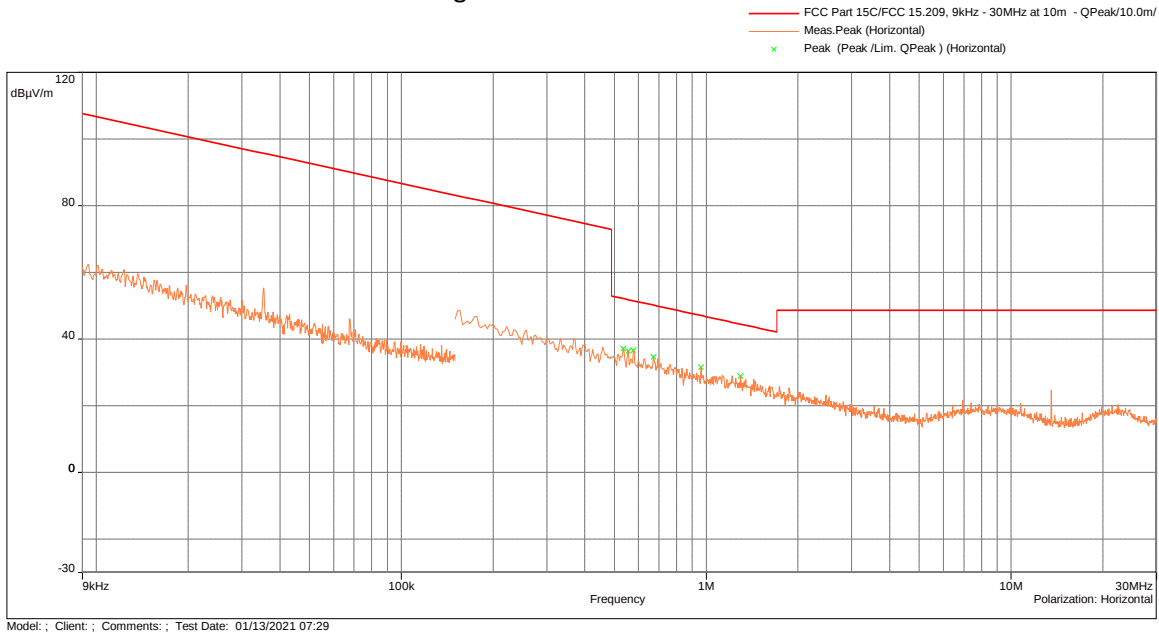


Radiated Spurious Emissions from 9 kHz to 30MHz, EUT Flat on Side (Z-Axis)

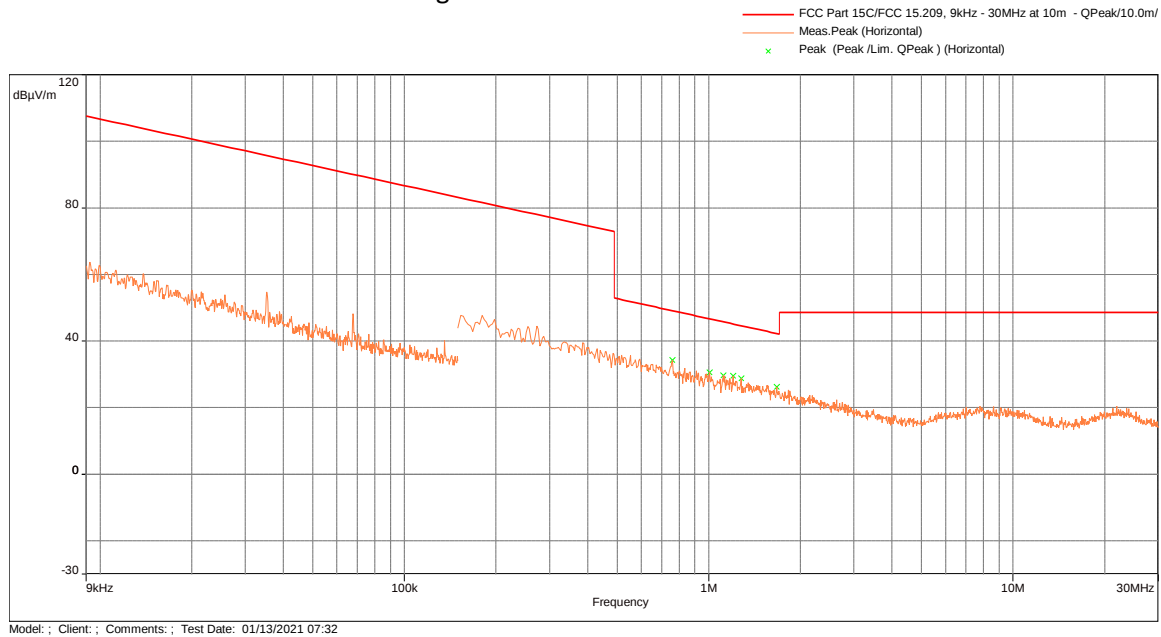
Receiving Antenna Coplanar Orientation



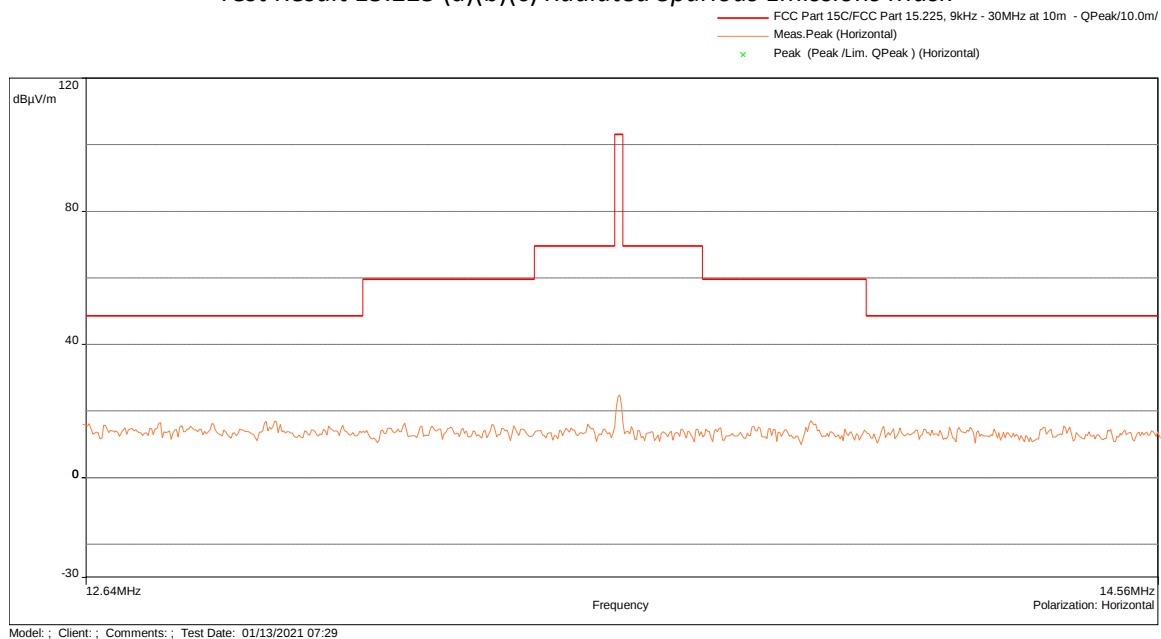
Receiving Antenna Coaxial Orientation



Receiving Antenna Horizontal Orientation



Test Result 15.225 (a)(b)(c) Radiated Spurious Emissions Mask

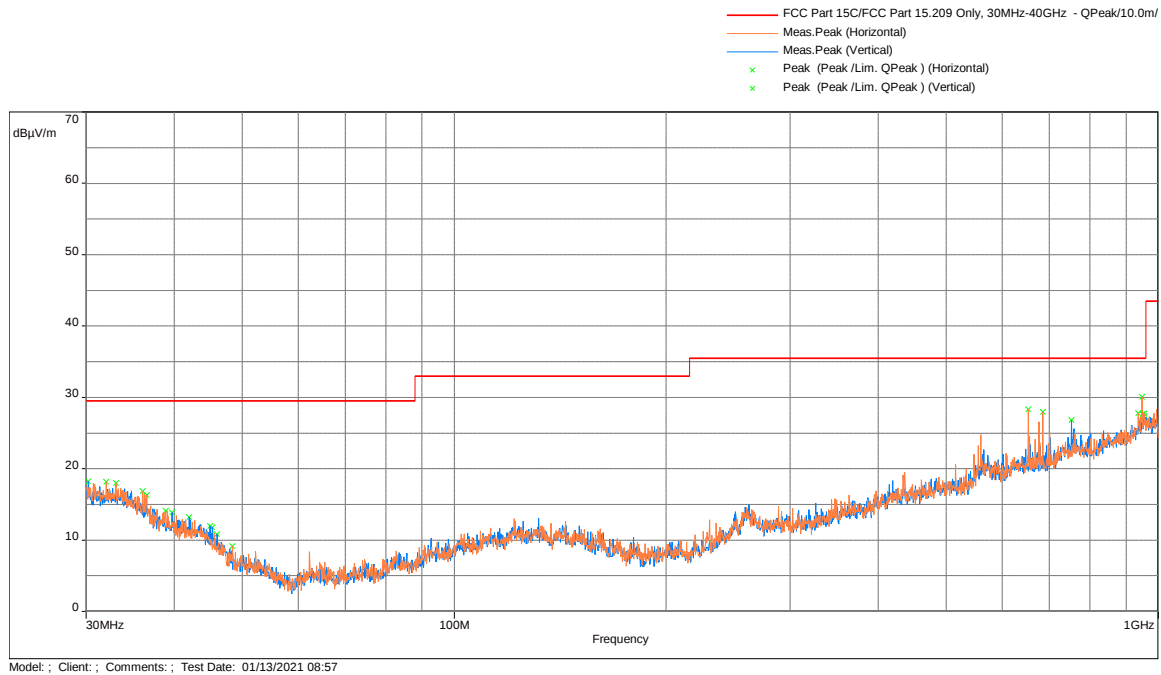


Frequency (MHz)	Peak FS@10m dB(μV/m)	Limit@10m dB(μV/m)	Margin dB	Comment	Correction dB
13.56	24.8	103.1	78.3	Coaxial	2.89

Note: Correction = AF+CF-AG- distance correction factor

Distance correction factor= $40 \cdot \log_{10}(\text{limit distance}/\text{measured distance})$

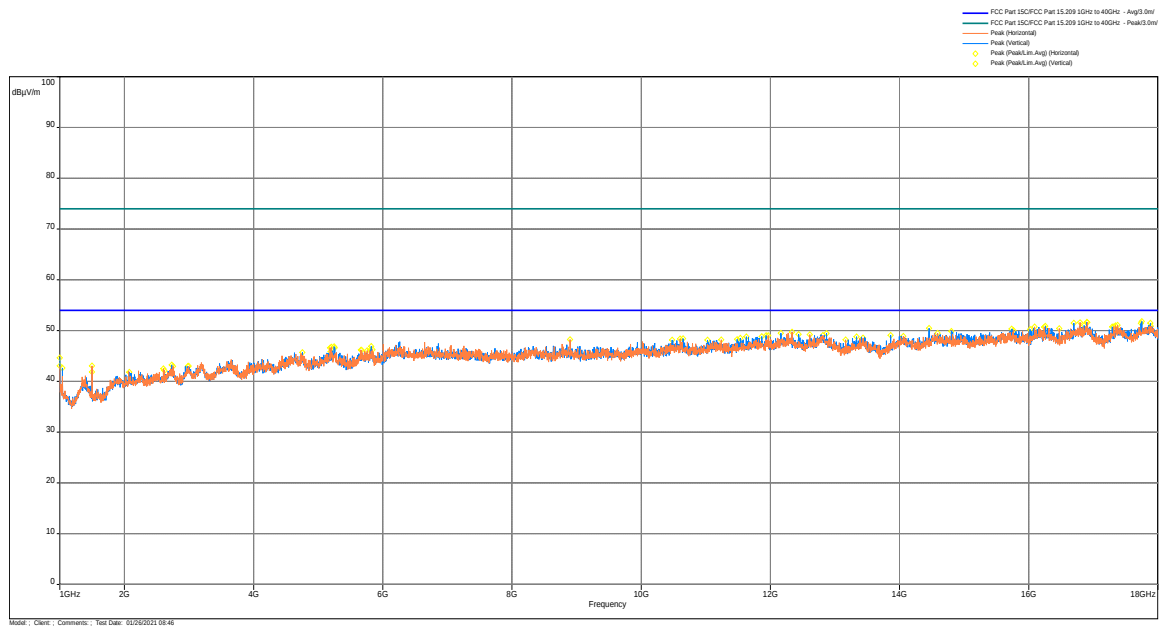
Radiated Spurious Emissions from 30 to 1000 MHz



Freq (MHz)	Peak FS @10m dB(uV/m)	Limit @10m dB(uV/m)	Margin (dB)	Height (m)	Azimuth (Deg)	Polarity	Correction (dB)
702.598	28.18	35.5	-7.32	0.99	175	Vertical	-4.65
708.159	27.84	35.5	-7.66	0.99	84	Vertical	-4.47
747.476	27.57	35.5	-7.93	1.98	0	Vertical	-2.83
763.675	29.80	35.5	-5.70	0.99	111	Vertical	-2.74
771.856	28.75	35.5	-6.75	0.99	147	Vertical	-2.76
952.793	27.69	35.5	-7.81	0.99	340	Vertical	1.85

Note: Correction = AF + CF –AG

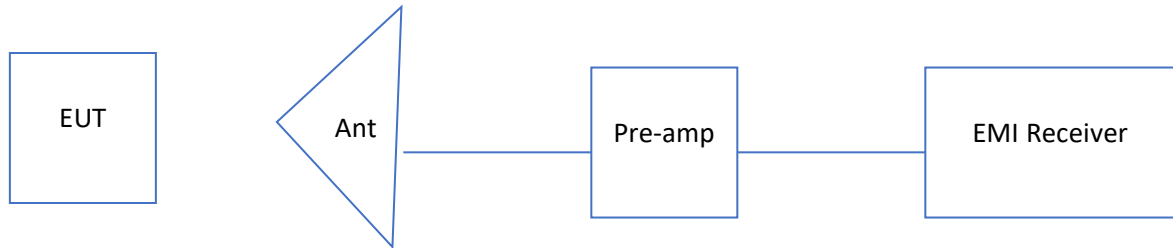
Radiated Spurious Emissions from 1 to 18 GHz, Peak Scan vs Avg and Peak Limits



Result Complies by 5.48dB

4.1.4 Test Configuration Photographs

The following photographs show the testing configurations used.



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 with the battery fully charged.

4.2.3 Test Results 15.225 (e)

Nominal Frequency: 13559659 Hz

Voltage (DC)	Temperature (C)	Measured Frequency (Hz)	Deviation from Reference (Hz)	Deviation (%)
Fully charged Battery	-20	13559696	36.0575	0.0003
Fully charged Battery	-10	13559814	154.6490	0.0011
Fully charged Battery	0	13559723	63.3010	0.0005
Fully charged Battery	10	13559714	54.4865	0.0004
Fully charged Battery	20	13559659	0.0000	0.0000
Fully charged Battery	30	13559688	28.8455	0.0002
Fully charged Battery	40	13559647	-12.0195	-0.0001
Fully charged Battery	50	13559618	-41.6670	-0.0003

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

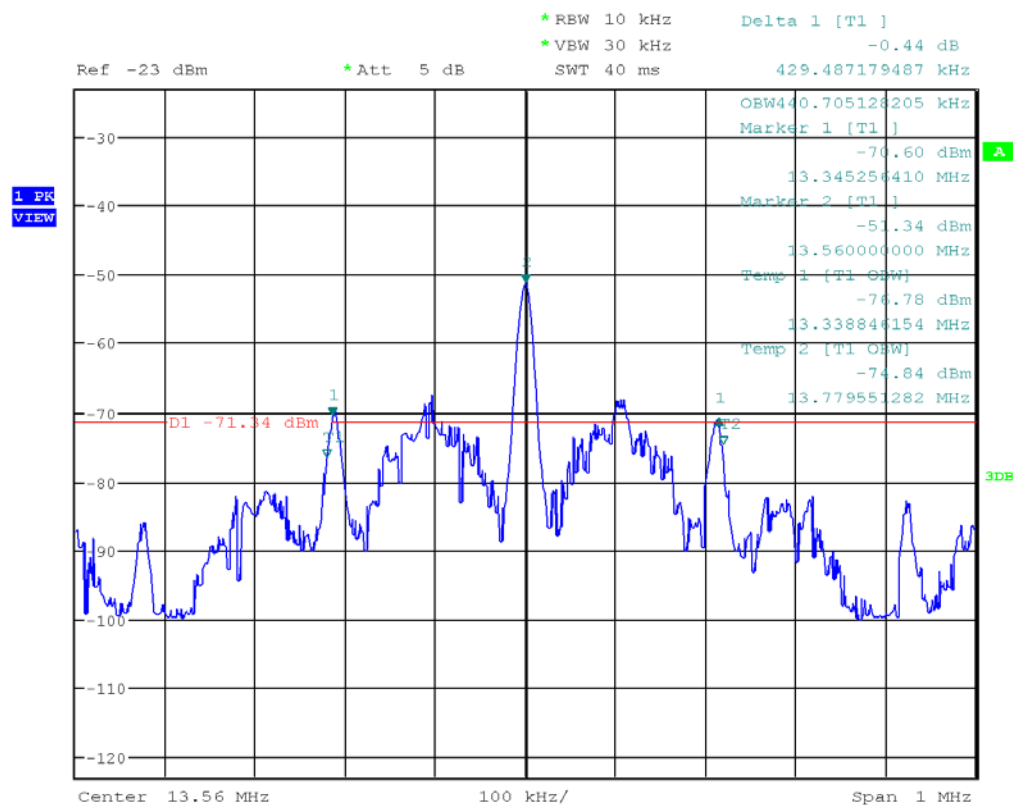
The EUT was setup to transmit in normal operating condition.

Measurements were made with the loop antenna in close proximity of the EUT. Following the procedures of ANSI 63.10: 2013, 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	429.487	440.705

-20dB & 99% Channel Bandwidth Plot



Date: 1.DEC.2020 08:51:07

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 #	Cal Int	Cal Due
EMI Receiver	Rohde and Schwarz	ESU40	ITS 00961	12	03/09/21
Loop Antenna	EMCO	6512	ITS 01598	12	11/03/21
Active Horn Antenna	ETS-Lindgren	3117-PA	ITS 1636	12	12/17/21
Notch Filter	Micro-Tronics	BRC50702	ITS 01166	12	06/11/21
BI-Log Antenna	Teseq	CBL611D	ITS 01058	12	11/12/21
Pre-Amplifier	Sonoma Instrument	310N	ITS 01493	12	02/07/21
RF Cable	TRU Corporation	TRU CORE 300	ITS 01462	12	09/01/21
RF Cable	TRU Corporation	TRU CORE 300	ITS 01465	12	09/01/21
RF Cable	TRU Corporation	TRU CORE 300	ITS 01470	12	09/01/21
RF Cable	TRU Corporation	TRU CORE 300	ITS 01342	12	09/01/21
RF Cable	Mega Phase	EMC1-K1K1-236	ITS 01537	12	04/17/21
RF Cable	Mega Phase	TM40-K1K1-19	ITS 01155	12	04/17/21
Spectrum Analyzer	Rohde and Schwarz	FSU	ITS 00913	12	05/11/21
Loop Sensor	Solar Electronics	7334-1	ITS 01608	12	11/10/21
Temperature Test Chamber	ESPEC	BTX-475	ITS 01436	12	10/20/21

Software used for emission compliance testing utilized the following:

Name	Manufacturer	Version	Template/Profile
BAT-EMC	Nexio	3.19.1.19	Philips_RFID.bpp
RS Commander	Rohde Schwarz	1.6.4	Not Applicable (Screen grabber)

6.0 Document History

Revision/ Job Number	Writer Initials	Reviewer Initials	Date	Change
1.0 / G104498238	AS	KV	March 03, 2021	Original document