

TEST REPORT

Report Number: 104360835MPK-001

Project Number: G104360835

August 07, 2020

**Testing performed on the
FUYL Tower Pro Control Door
Model: ELE-00368-01**

FCC ID: 2AXFV-ELE0036801

IC: 26455-ELE0036801

to

**FCC Part 15 Subpart C (15.209)
FCC Part 15 Subpart C (15.225)
Industry Canada RSS-210 Issue 10**

For

IWS Global Pty Ltd

Test Performed by:

Intertek

1365 Adams Court

Menlo Park, CA 94025 USA

Test Authorized by:

IWS Global Pty Ltd

29 Oxleigh Drive

Magala WA 6090, Australia

Prepared by:



Hung Huynh

Date: August 07, 2020

Reviewed by:



Krishna Vemuri

Date: August 07, 2020

This report is for the exclusive use of Intertek's Client and is provided pursuant to the agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this report. Only the Client is authorized to copy or distribute this report and then only in its entirety. Any use of the Intertek name or one of its marks for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek. The observations and test results in this report are relevant only to the sample tested. This report by itself does not imply that the material, product, or service is or has ever been under an Intertek certification program. This report must not be used to claim product endorsement by A2LA, NIST nor any other agency of the U.S. Government.

Report No. 104360835MPK-001

Equipment Under Test:	FUYL Tower Pro Control Door
Trade Name:	IWS Global Pty Ltd
Model:	ELE-00368-01
Serial Number:	MPK2006281311-001
Applicant:	IWS Global Pty Ltd
Contact:	Jeff Cross
Address:	29 Oxleigh Drive Magala WA 6090
Country	Australia
Email	jeff.c@pclocs.com.au
Applicable Regulation:	FCC Part 15 Subpart C (15.209) FCC Part 15 Subpart C (15.225) Industry Canada RSS-210 Issue 10
Test Site Location:	ITS – Site 1 1365 Adams Drive Menlo Park, CA 94025
Date of Test:	June 28, 2020 to July 30, 2020

We attest to the accuracy of this report:



Hung Huynh
Project Engineer



Krishna K Vemuri
EMC Manager

TABLE OF CONTENTS

1.0	Summary of Tests	5
2.0	General Description	6
2.1	Product Description	6
2.2	Related Submittal(s) Grants	7
2.3	Test Methodology	7
2.4	Test Facility	7
2.5	Measurement Uncertainty	7
3.0	System Test Configuration.....	8
3.1	EUT Photo	8
3.2	Block Diagram of Test Setup.....	8
3.3	Justification	9
3.4	Software Exercise Program.....	9
3.5	Mode of Operation during test.....	9
3.6	Modifications required for Compliance.....	9
3.7	Additions, deviations and exclusions from standards.....	9
4.0	Measurement Results.....	10
4.1	Field Strength of Fundamental and Radiated Emissions Outside the band	10
4.1.1	Requirements	10
4.1.2	Procedure	11
4.1.3	Test Result 15.225 (a)(b)(c).....	12
4.1.4	Test Result 15.225 (d) and 15.209	13
4.1.5	Test Configuration Photographs	19
4.2	Frequency Tolerance.....	22
4.2.1	Requirement.....	22
4.2.2	Procedure	22
4.2.3	Test Results 15.225 (e)	23
4.3	Occupied Bandwidth.....	24
4.3.1	Requirements	24
4.3.2	Procedure	24
4.3.3	Test Results.....	25
4.4	AC Line Conducted Emission	29
4.4.1	Requirement.....	29
4.4.2	Procedure	29
4.4.3	Test Result	30
5.0	List of test equipment	33
6.0	Document History	34
7.	Appendix A: Evaluation for spurious emissions of pre-certified radio module installed inside the host equipment per KDB 996369 D04.....	35
A1.0	Radiated Emissions (ANSI C63.10)	35
A1.1	Method	35

A1.2 Test Equipment Used:.....	37
A1.3 Result:	37
A1.4 Photographs:	38
A1.5 Test Data for 2.4GHz BLE, WiFi 5GHz:.....	41
A1.6 Test Data for 2.4GHz BLE, WiFi 2.4 GHz:.....	47

1.0 Summary of Tests

TEST	REFERENCE FCC 15C	REFERENCE RSS-210	RESULTS
Radiated Emissions	15.209	RSS 210 (4.3)	Complies
Line Conducted Emissions	15.207	RSS-GEN	Complies
Occupied Bandwidth	15.215(c)	RSS-GEN	Complies
Antenna requirement	15.203	RSS-GEN	Complies ¹

¹ The EUT utilizes an internal Antenna.

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	Complies
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

IWS Global Pty Ltd supplied the following description of the EUT:

The EUT is used to provide a user interface via LCD screen, keypad and RFID for the purpose of controlling various locker style storage compartments. The EUT also provides communication to external servers both fixed & wireless for the purpose of provide controlled access and asset management of stored devices.

Overview of the EUT

Applicant name & address	IWS Global Pty Ltd 29 Oxleigh Drive Magala WA 6090 Australia
Contact info / Email	Jeff Cross / jeff.c@pclocs.com.au
Model Number	ELE-00368-01
FCC Identifier	2AXFV-ELE0036801
IC Identifier	26455-ELE0036801
Operating Frequency	125 kHz, 13.56 MHz
Number of Channels	1 each frequency (RFID)
Type of Modulation	ASK Modulation (RFID)
Antenna Type	Wirewound coil (125kHz) PCB Trace Antenna (13.56 MHz)

EUT receive date: June 26, 2020

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: June 28, 2020

Test completion date: July 30, 2020

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: 2014. 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 EUT Photo

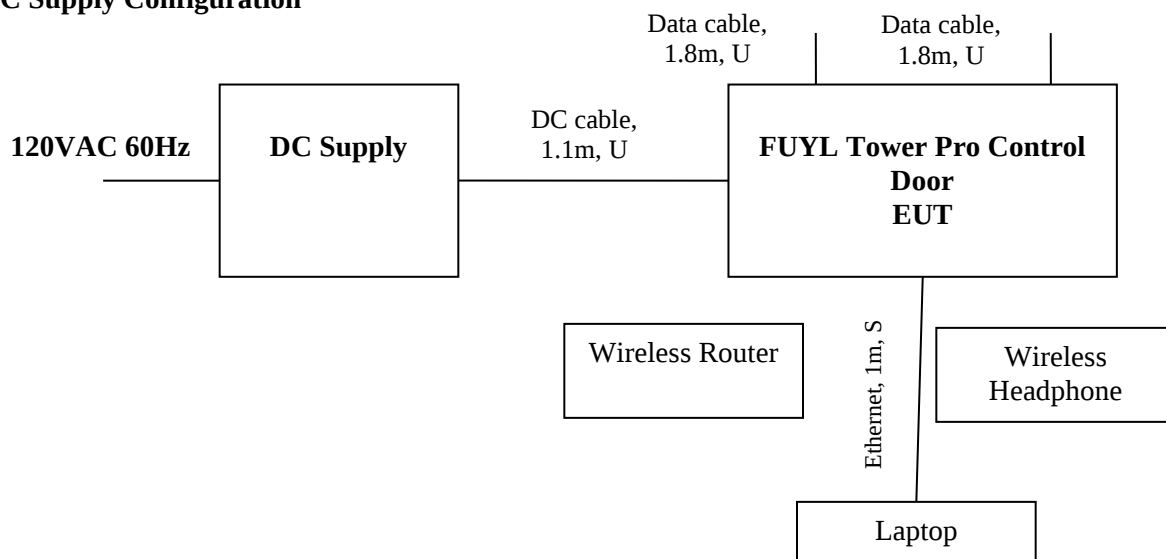


3.2 Block Diagram of Test Setup

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.

Support Equipment		
Description	Manufacturer	Model No.
DC Power Supply	BK Precision	1550
Wireless Headphone	Beats	Studio
Laptop	HP	EliteBook 8460p
Wireless Router	TP Link	C7

DC Supply Configuration



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.

Evaluation for spurious emissions of pre-certified radio module installed inside Host equipment was performed. Radio module FCC ID: COF-WMBACBM25. See Appendix A for test data and setup photos.

3.4 Software Exercise Program

Raspberry OS was used as Engineering Software during testing.

3.5 Mode of Operation during test

The FUYL Tower Pro Control Door was set up to continuously transmitting at 125kHz and 13.56MHz. In addition, during tests the EUT was paired and exercised with wireless headphone for BLE connection and wireless router for WiFi connection.

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, 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	$2400/F(\text{kHz})$	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 (μ V/m)

RA = Receiver Amplitude (including preamplifier) in dB (μ V)

CF = Cable Attenuation Factor in dB

AF = Antenna Factor in dB (1/m)

AG = Amplifier Gain in dB

DCF = Distance Correction Factor

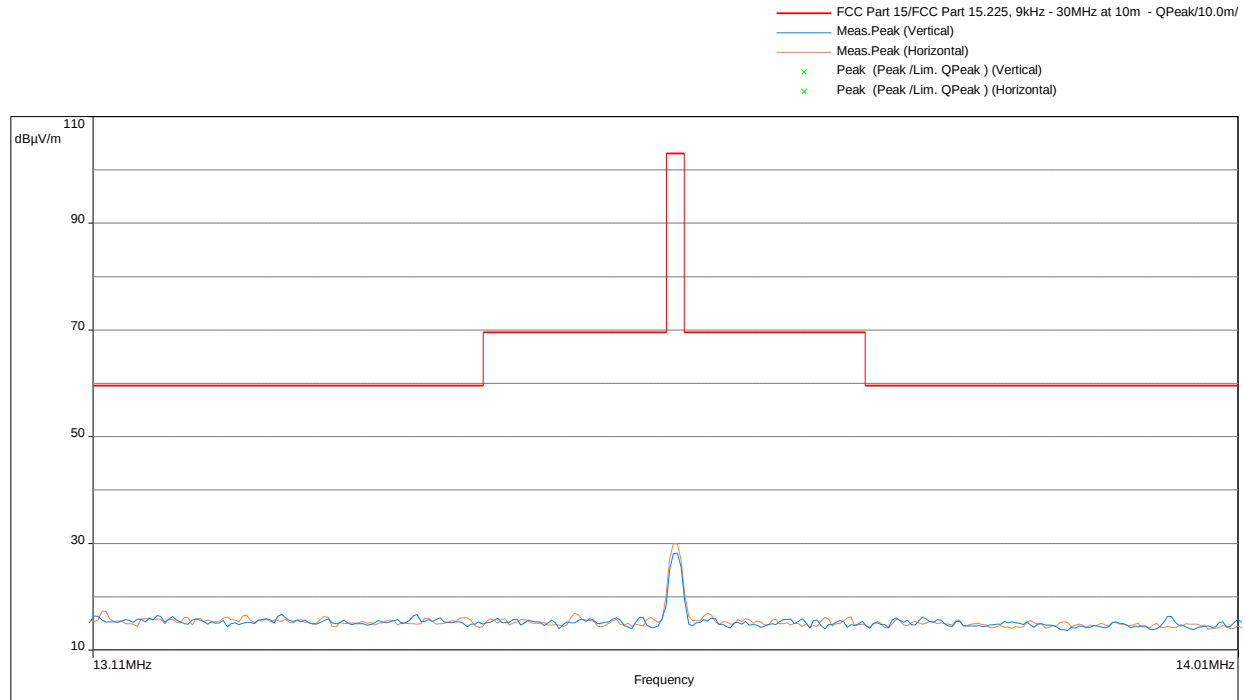
Note: FS was measured with loop antenna below 30MHz

4.1.3 Test Result 15.225 (a)(b)(c)

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. The worst case data was presented below.

Fundamental at 13.56MHz



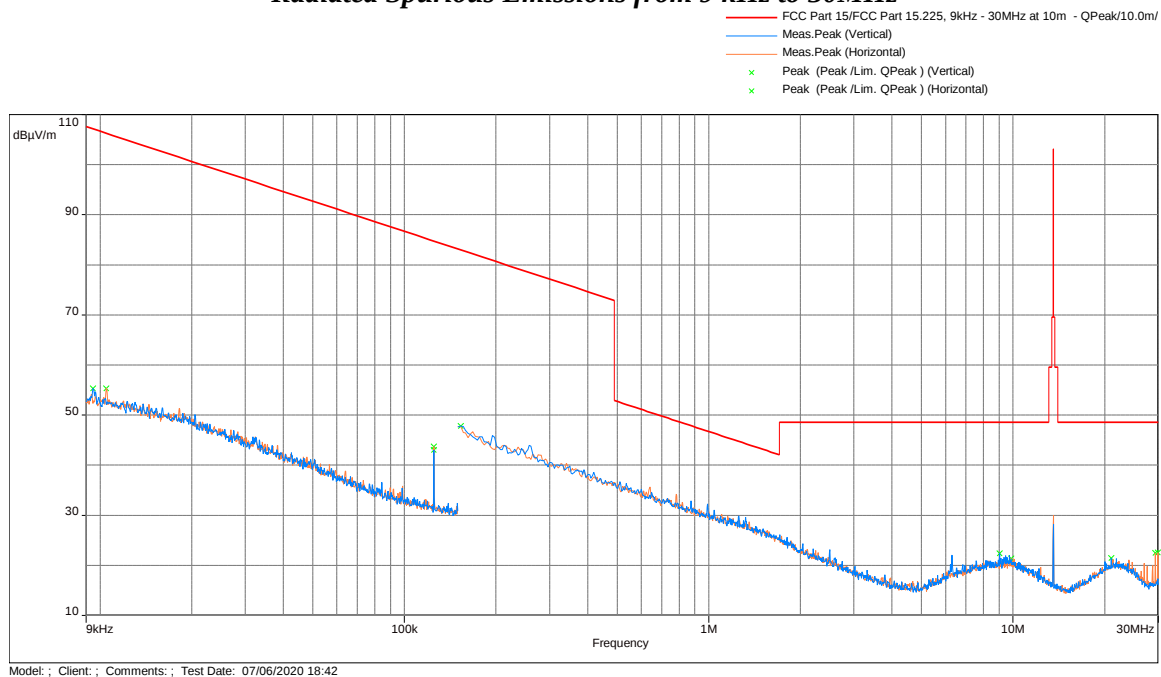
Frequency	Peak FS@10m	Limit@10m	Margin	Polarity	RA@10m	Correction
(MHz)	dB(uV/m)	dB(uV/m)	dB		dB(uV)	dB
13.56	29.95	103.1	-73.15	parallel	32.61	2.66
13.56	28.18	103.1	-74.92	perpendicular	30.84	2.66

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

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

4.1.4 Test Result 15.225 (d) and 15.209

Radiated Spurious Emissions from 9 kHz to 30MHz

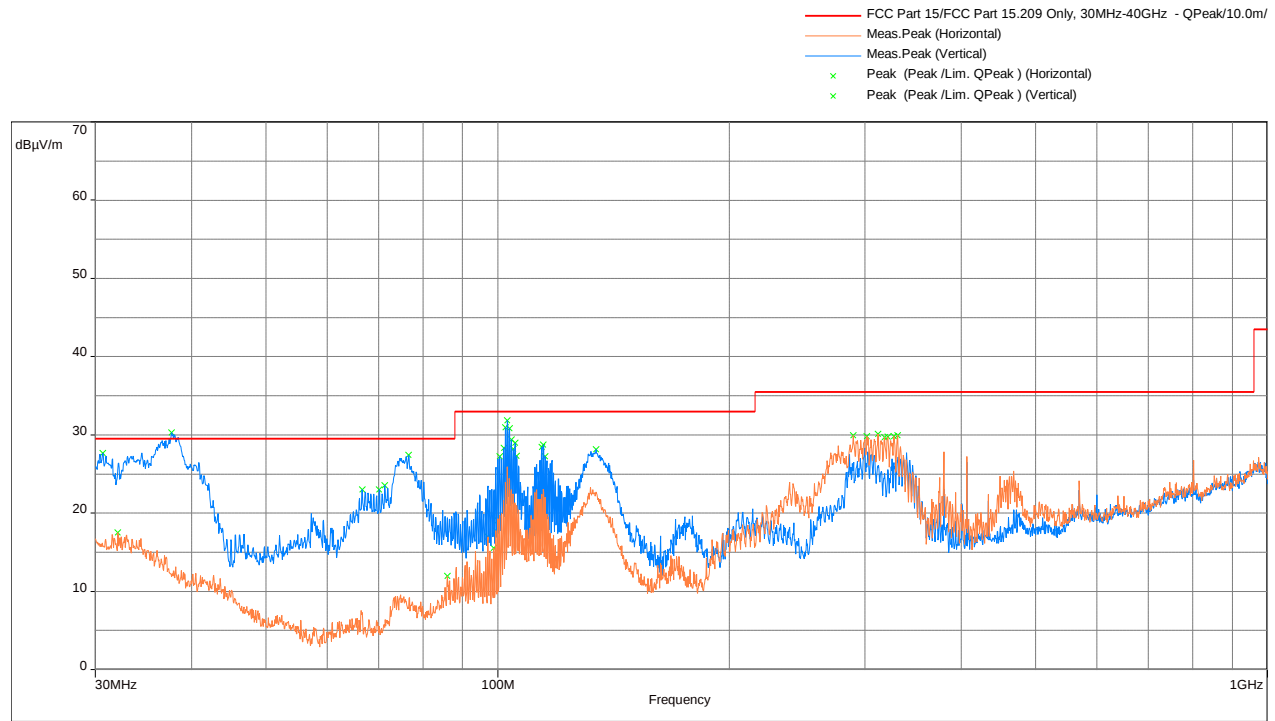


Frequency	Peak FS@10m	Limit@10m	Margin	Polarity	RA@10m	Correction
(MHz)	dB(uV/m)	dB(uV/m)	dB		dB(uV)	dB
0.125	43.01	84.76	-41.75	Parallel	74.57	31.56
0.125	43.68	84.76	-41.08	Perpendicular	75.24	31.56

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 MHz to 1000 MHz

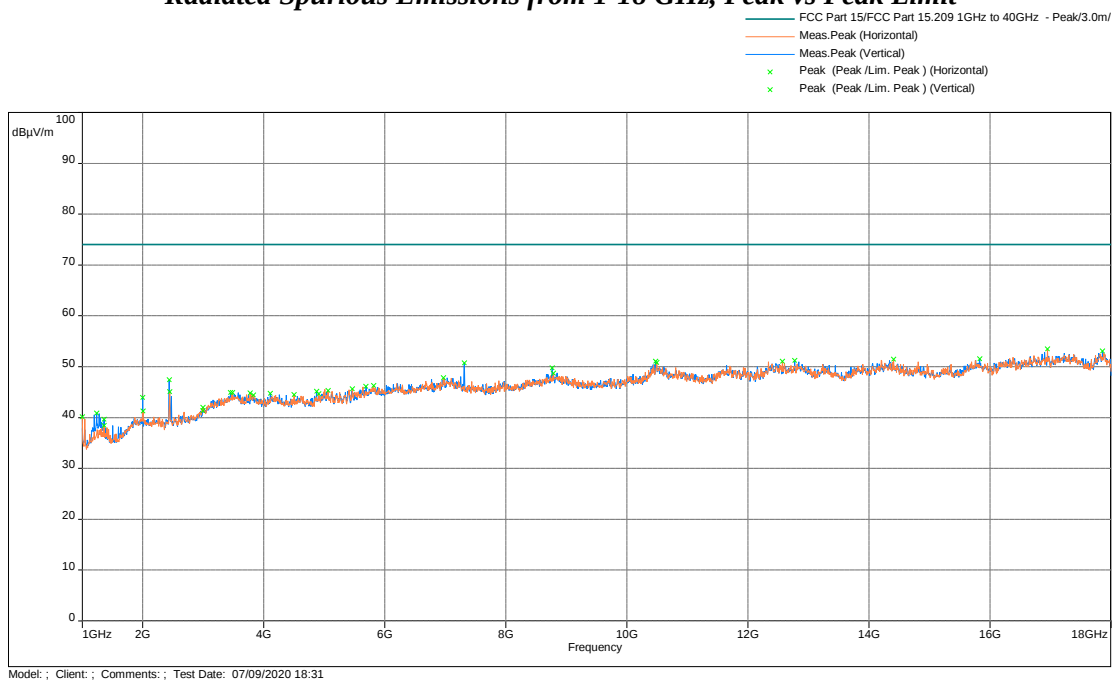


Freq (MHz)	FS @10m dB(uV/m)	Limit dB(uV/m)	Margin (dB)	Azimuth (Deg)	Height (m)	Polarity	RA@10m (dBuV)	Correction (dB)
31.02459	24.56	29.50	-4.94	157.50	1.00	Vertical	33.62	-9.23
37.78766	27.19	29.50	-2.31	297.50	1.43	Vertical	39.85	-12.72
102.9436	30.35	33.00	-2.65	216.75	1.28	Vertical	47.24	-16.89
290.0233	27.35	35.50	-8.15	191.25	2.86	Horizontal	40.72	-13.37
311.8711	27.44	35.50	-8.06	182.25	2.46	Horizontal	40.36	-12.92
330.5964	27.13	35.50	-8.37	171.50	2.81	Horizontal	39.61	-12.49

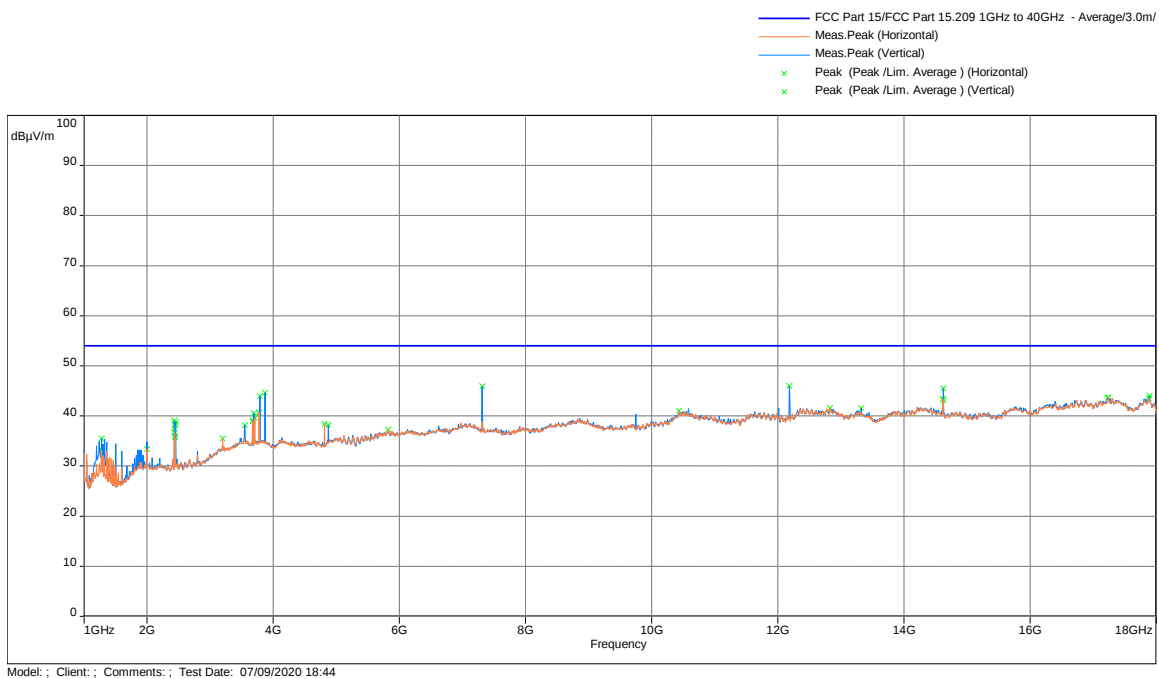
Note: FS = RA + Correction

Correction = AF + CF – Preamp

Radiated Spurious Emissions from 1-18 GHz, Peak vs Peak Limit



Radiated Spurious Emissions from 1-18 GHz, Average vs Average Limit

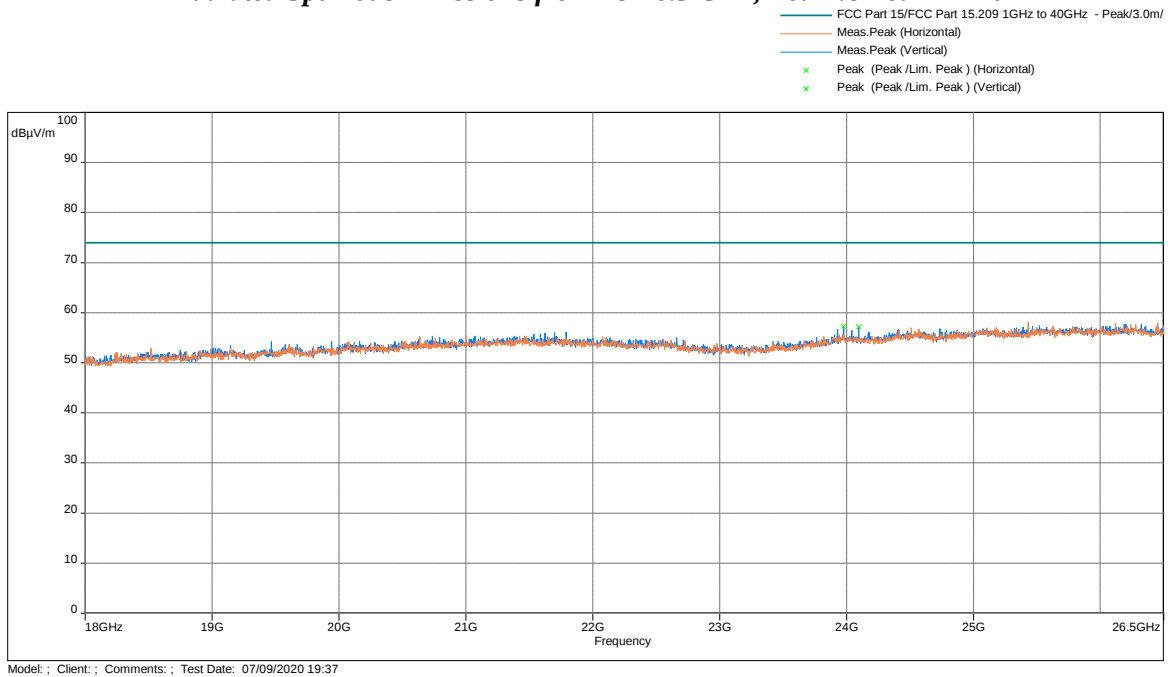


Frequency (MHz)	FS (dBμV/m)	Ave Limit (dBμV/m)	Ave Margin (dB)	Azimuth (deg)	Height (m)	Polarity	RA (dBuV)	Correction (dB)
12183.73	46.03	54.00	-7.97	212.00	1.51	Vertical	46.44	0.41
7310.4	45.94	54.00	-8.06	124.25	1.73	Vertical	44.04	-1.90
14622.1	45.49	54.00	-8.51	300.75	1.80	Vertical	48.59	3.10
3869.6	44.63	54.00	-9.37	10.00	1.98	Vertical	37.18	-7.45

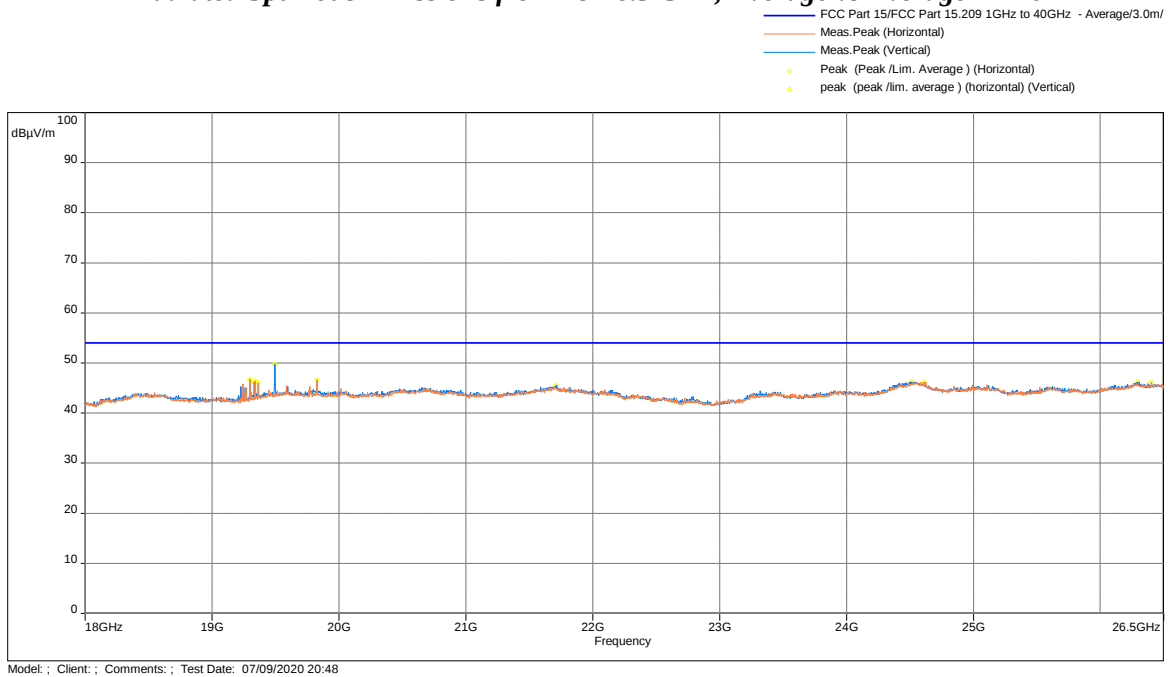
Note: FS = RA + Correction

Correction = AF + CF – Preamp

Radiated Spurious Emissions from 18-26.5 GHz, Peak vs Peak Limit



Radiated Spurious Emissions from 18-26.5 GHz, Average vs Average Limit



Frequency (MHz)	Peak (dBμV/m)	Lim. Average (dBμV/m)	Peak- Limit (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
19495.72	49.74	54.00	-4.26	1.98	27.00	Vertical	4.02
19299.93	46.74	54.00	-7.26	3.99	357.75	Horizontal	3.47

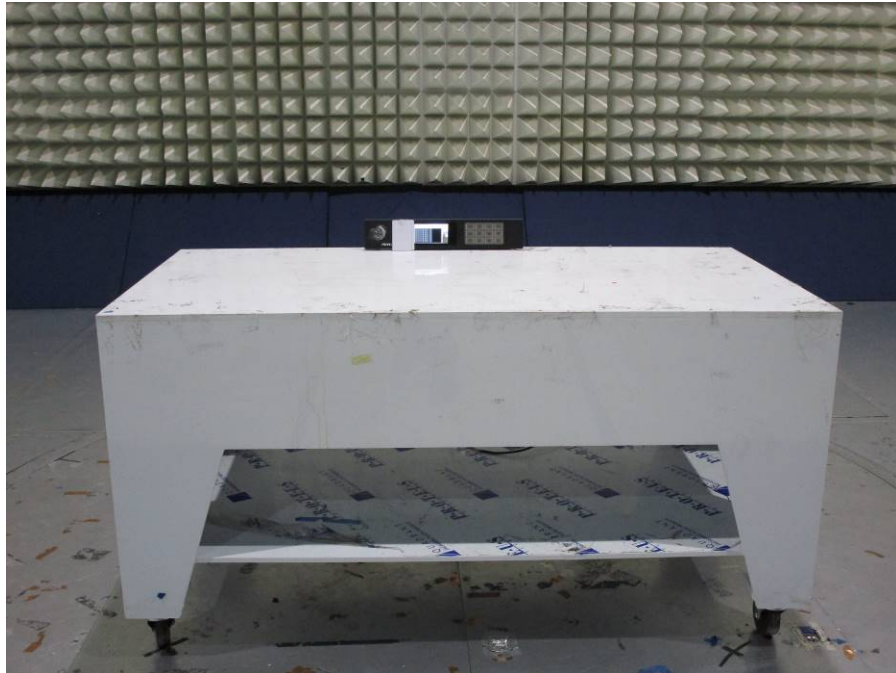
Note: FS = RA + Correction

Correction = AF + CF – Preamp

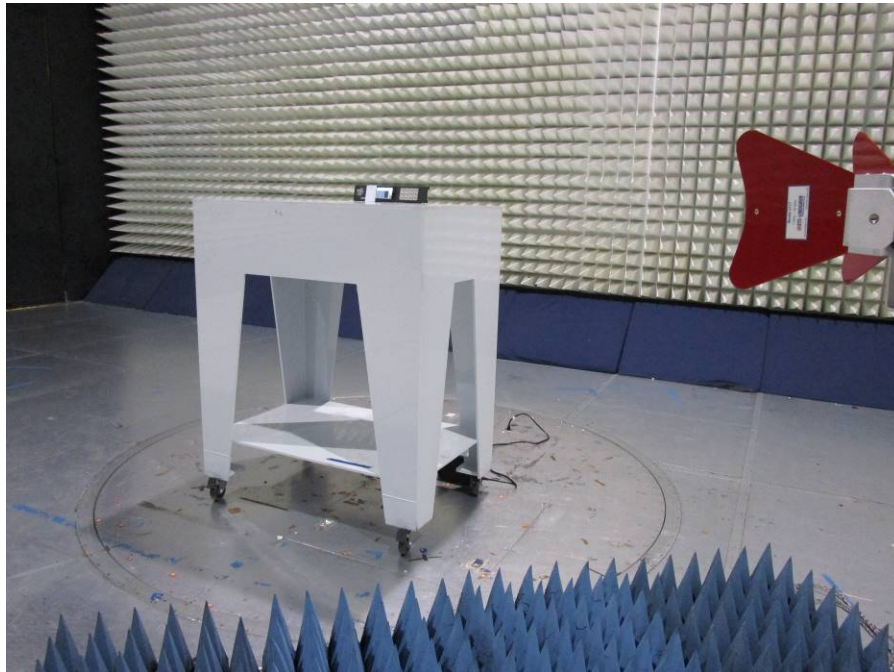
Result	Complies by 2.31 dB
---------------	----------------------------

4.1.5 Test Configuration Photographs

The following photographs show the testing configurations used.

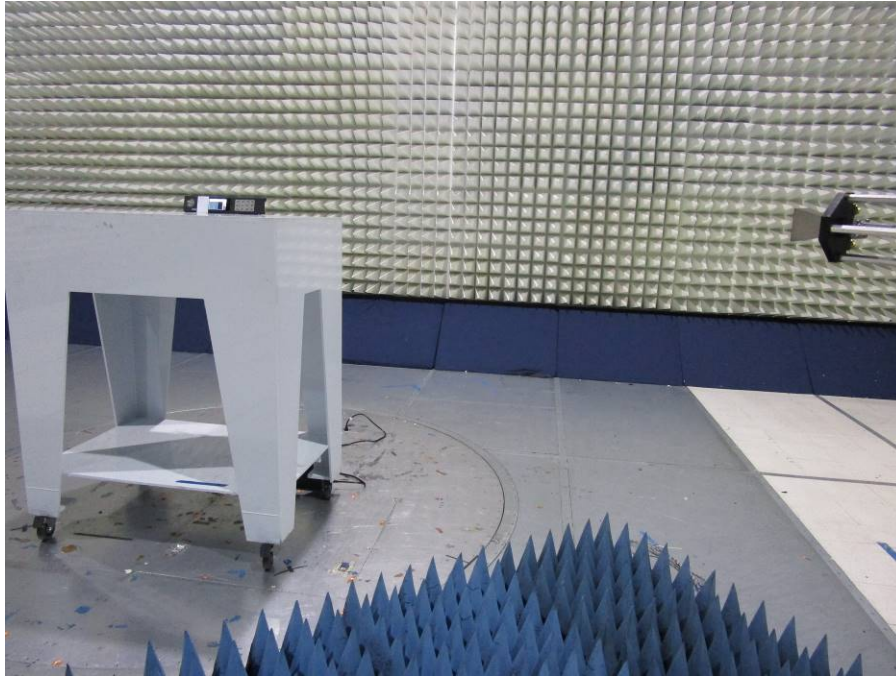


4.1.5 Test Configuration Photographs (Continued)



Electromagnetic Radiated Disturbance Setup Photograph

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. In addition, the carrier frequency was recorded when the power was set to 27.6 V DC (115% of 24V DC) and to 20.4 V DC (85% of 24V DC).

4.2.3 Test Results 15.225 (e)

Nominal Frequency: 13560000 Hz

Voltage (DC)	Temperature (C)	Measured Frequency (Hz)	Deviation from Reference (Hz)	Deviation (%)
24	-20	13560730	730	0.00538
24	-10	13560512	512	0.00378
24	0	13560381	381	0.00281
24	10	13560360	360	0.00265
24	20	13560302	302	0.00223
24	30	13560325	325	0.00240
24	40	13560342	342	0.00252
24	50	13560480	480	0.00354
20.4	20	13560225	225	0.00166
27.6	20	13560327	327	0.00241

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.

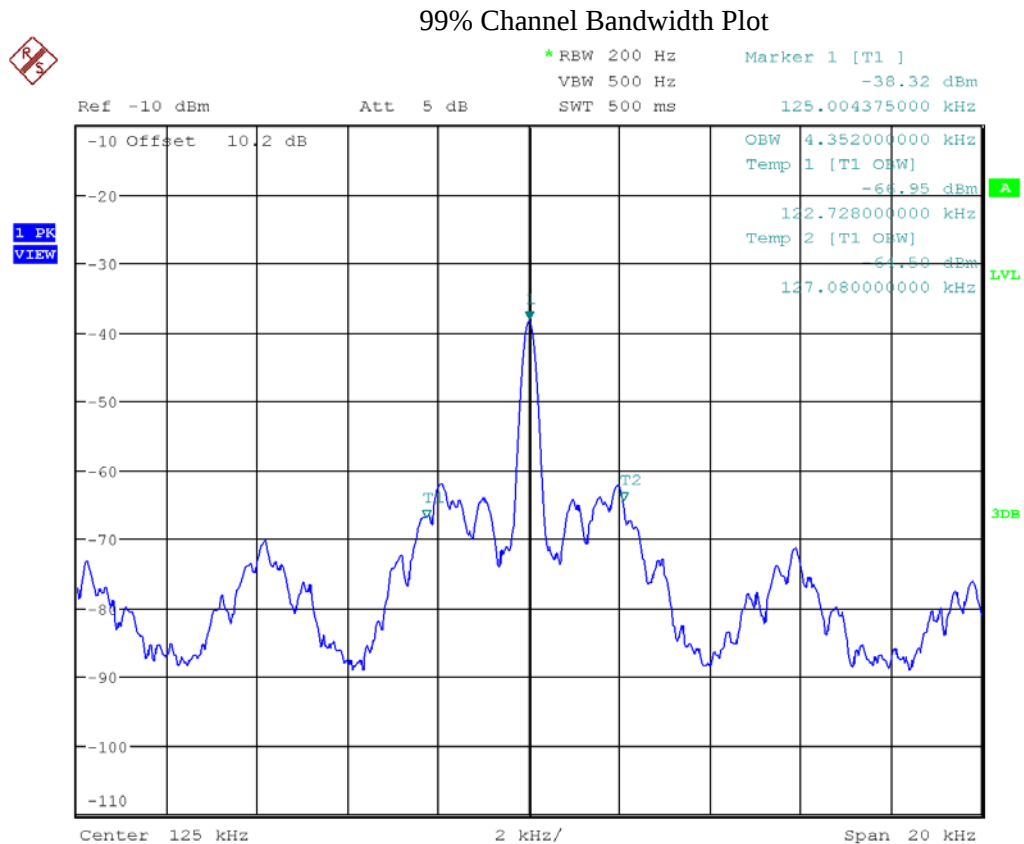
4.3.2 Procedure

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)
0.125	0.528	4.352



Date: 2.JUL.2020 16:52:59

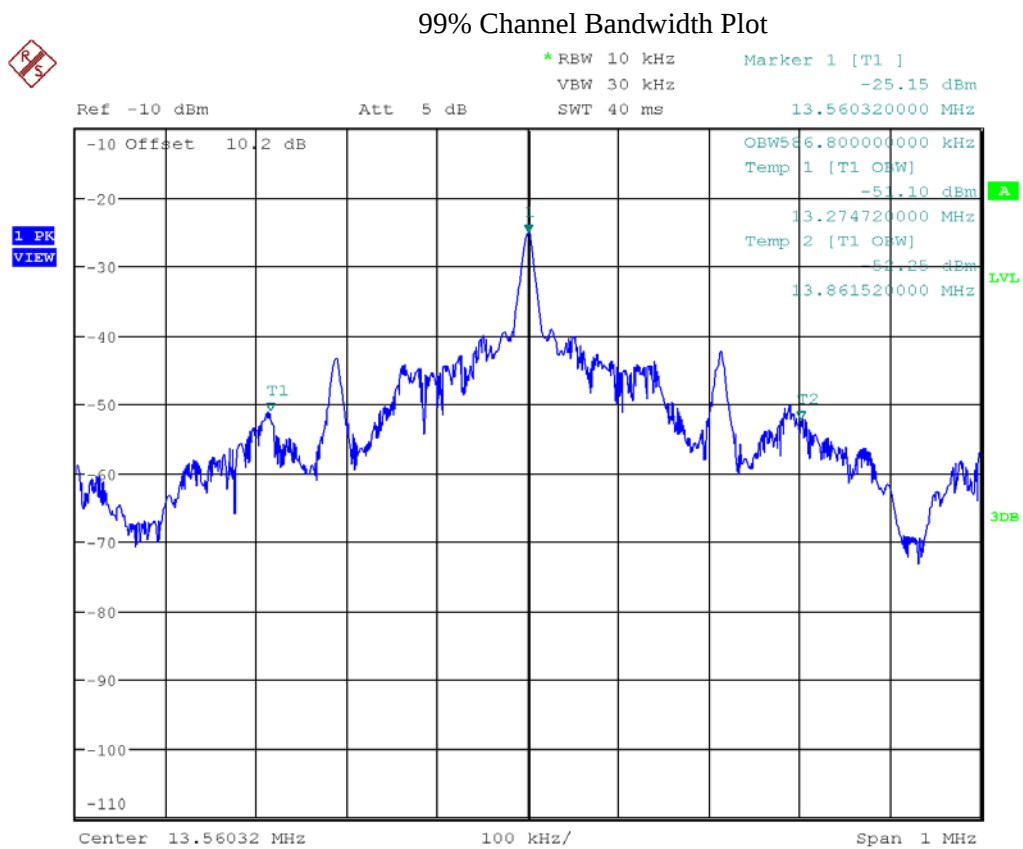
-20dB Channel Bandwidth Plot



Date: 2.JUL.2020 16:55:24

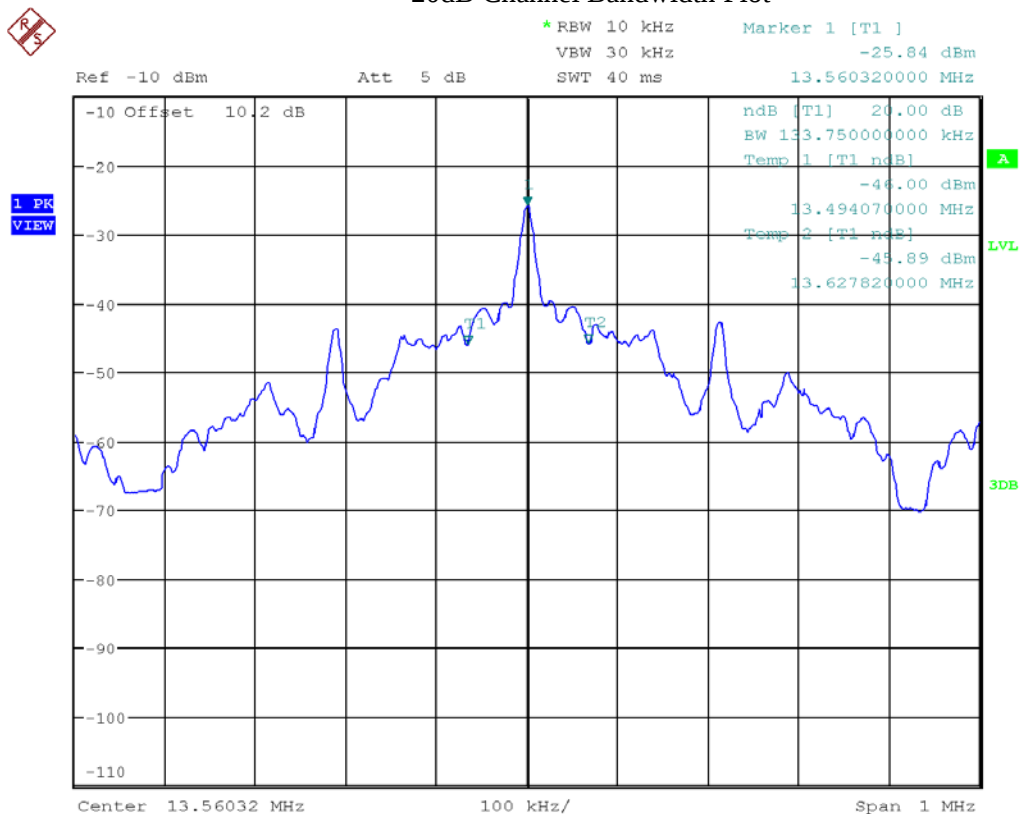
4.3.3 Test Results (Continued)

Frequency (MHz)	-20 dB Channel Bandwidth (kHz)	99% Channel Bandwidth (kHz)
13.56	133.750	586.800



Date: 2.JUL.2020 17:17:42

-20dB Channel Bandwidth Plot



Date: 2.JUL.2020 17:34:00

4.4 AC Line Conducted Emission FCC Rule 15.207

4.4.1 Requirement

Frequency Band MHz	Class B Limit dB(μ V)		Class A Limit dB(μ V)	
	Quasi-Peak	Average	Quasi-Peak	Average
0.15-0.50	66 to 56 *	56 to 46 *	79	66
0.50-5.00	56	46	73	60
5.00-30.00	60	50	73	60

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

4.4.2 Procedure

Measurements are carried out using quasi-peak and average detector receivers in accordance with CISPR 16. An AMN is required to provide a defined impedance at high frequencies across the power feed at the point of measurement of terminal voltage and also to provide isolation of the circuit under test from the ambient noise on the power lines. An AMN as defined in CISPR 16 shall be used.

The EUT is located so that the distance between the boundary of the EUT and the closest surface of the AMN is 0.8m.

Where a flexible mains cord is provided by the manufacturer, this shall be 1m long or if in excess of 1m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0.4m in length.

The EUT is arranged and connected with cables terminated in accordance with the product specification.

Conducted disturbance is measured between the phase lead and the reference ground, and between the neutral lead and the reference ground. Both measured values are reported.

The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane. A vertical, metal reference plane is placed 0.4m from the EUT. The vertical metal reference-plane is at least 2m by 2m. The EUT shall be kept at least 0.8m from any other metal surface or other ground plane not being part of the EUT. The table is constructed of non-conductive materials. Its dimensions are 1m by 1.5m, but may be extended for larger EUT.

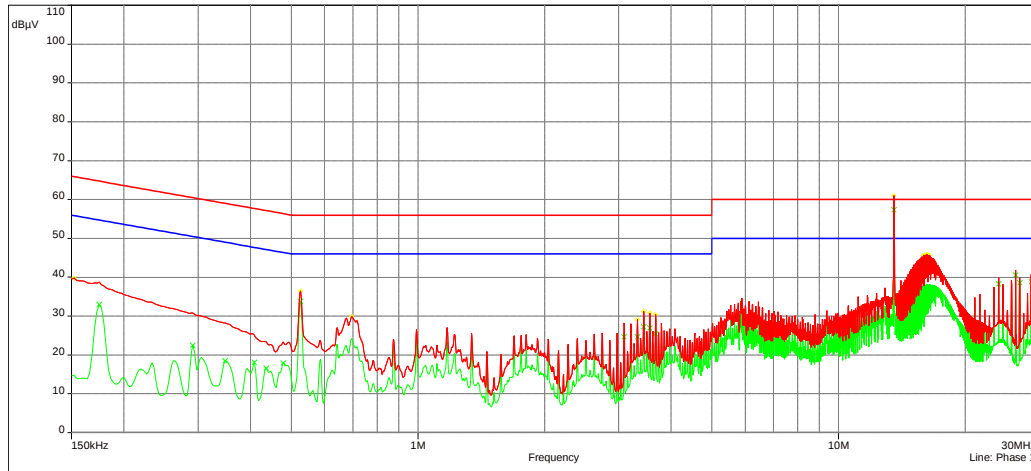
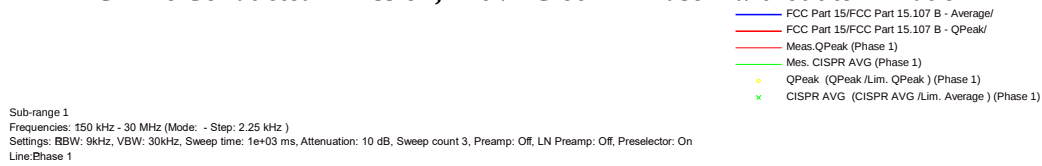
Floor standing EUT are placed on a horizontal metal ground plane and isolated from the ground plane by resting on an insulating material. The metal ground plane extends at least 0.5m beyond the boundaries of the EUT and has minimum dimensions of 2m by 2m.

EUT was placed in transmission mode then tested for conducted emissions per 15.207 to ensure the device complies with 15.207.

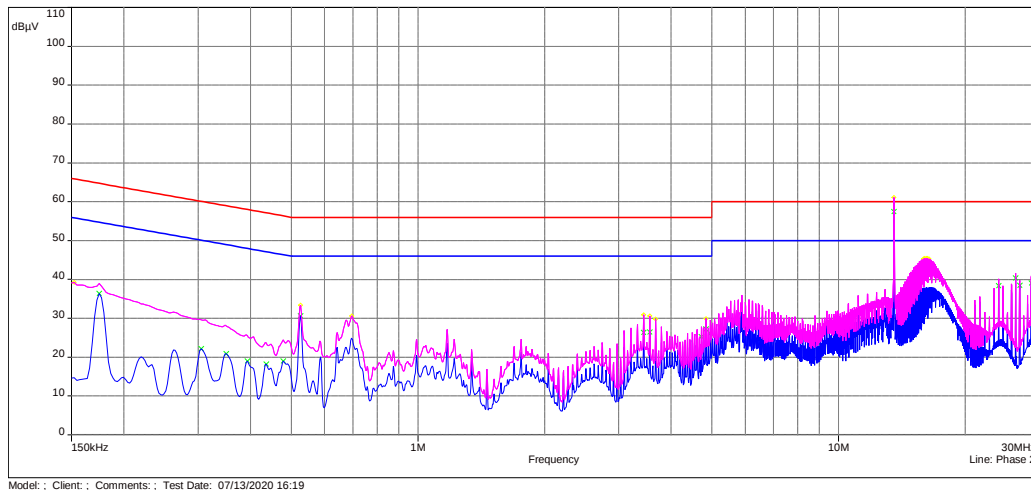
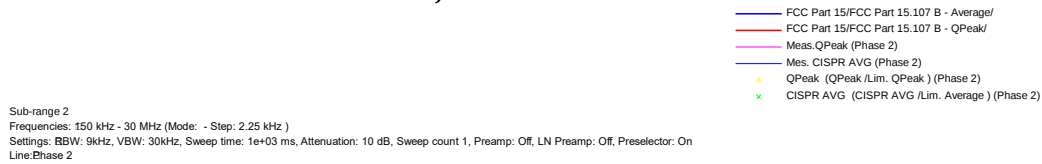
4.4.3 Test Result

FCC 15.207

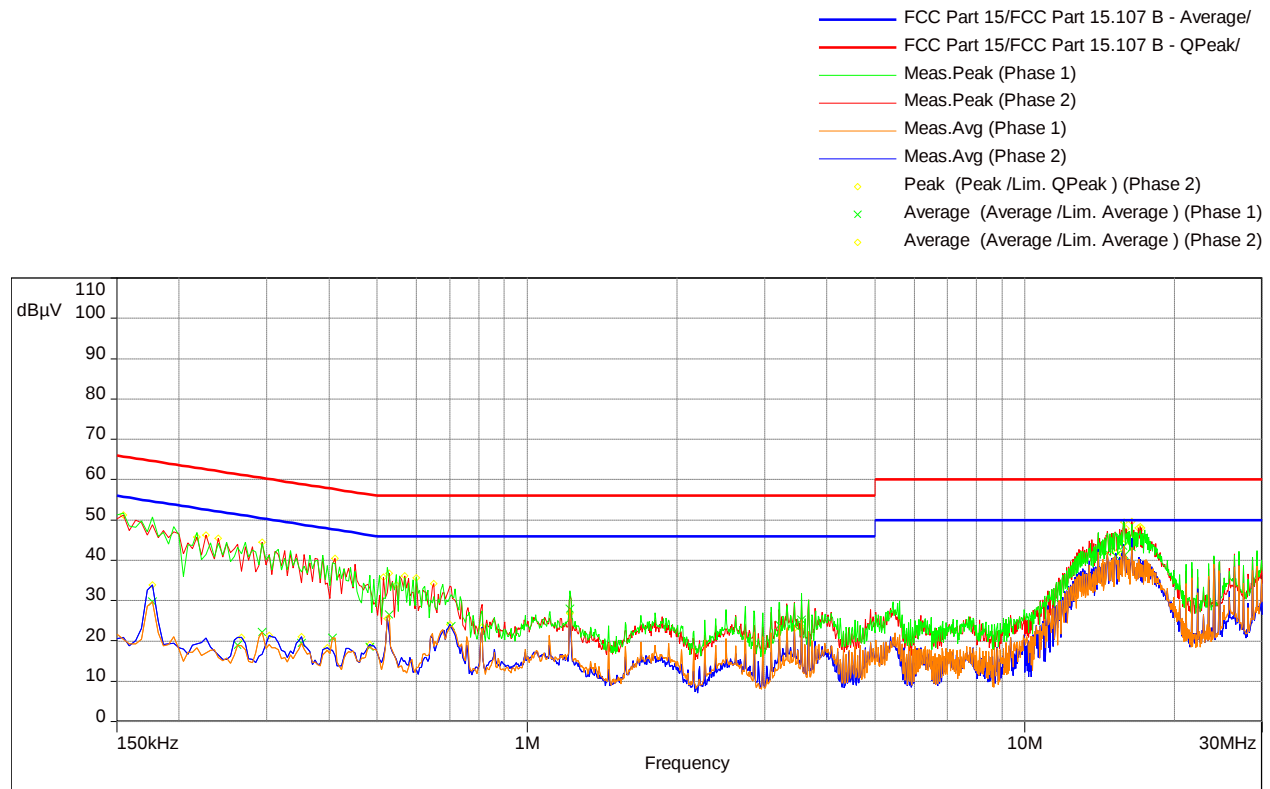
AC Line Conducted Emission, 120VAC 60Hz Phase 1 without termination



AC Line Conducted Emission, 120VAC 60Hz Phase 2 without termination



AC Line Conducted Emission, 120VAC 60Hz with RFID termination

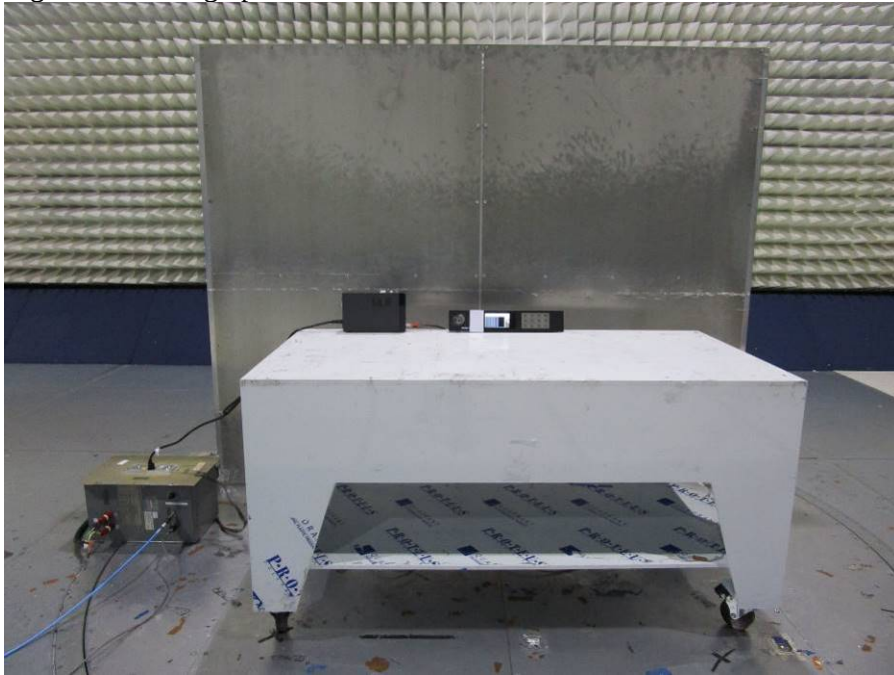


Model: ; Client: ; Comments: ; Test Date: 07/16/2020 17:29

Frequency (MHz)	Ave Level (dBμV)	QP Level (dBμV)	Ave Limit (dBμV)	QP Limit (dBμV)	Ave Margin (dB)	QP Margin (dB)	Line	Correction (dB)
0.177153	35.33	40.32	54.63	64.63	-19.29	-24.31	Phase 2	11.61
0.517548	22.67	28.66	46.00	56.00	-23.33	-27.34	Phase 1	10.91
0.531071	20.98	27.40	46.00	56.00	-25.02	-28.60	Phase 2	10.91
3.433241	26.48	30.79	46.00	56.00	-19.52	-25.21	Phase 1	10.95
3.550846	27.27	31.64	46.00	56.00	-18.73	-24.36	Phase 1	10.96
3.554617	26.41	30.98	46.00	56.00	-19.59	-25.02	Phase 2	10.96
4.837385	27.17	29.75	46.00	56.00	-18.83	-26.25	Phase 2	11.02
24.05234	35.92	39.71	50.00	60.00	-14.08	-20.29	Phase 1	11.54
26.39443	39.14	41.35	50.00	60.00	-10.86	-18.65	Phase 1	11.66
26.39587	39.91	41.58	50.00	60.00	-10.09	-18.42	Phase 2	11.71
29.32774	38.78	41.64	50.00	60.00	-11.22	-18.36	Phase 2	11.71
29.32943	38.70	41.32	50.00	60.00	-11.30	-18.68	Phase 1	11.68

Result	Complies by 10.09 dB
---------------	-----------------------------

4.3.4 Test Configuration Photographs



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	Cal Due
EMI Receiver	Rohde and Schwarz	ESU	ITS 00961	12	03/09/21
Passive Loop	EMCO	6512	ITS 001598	12	10/22/20
Pre-Amplifier	Sonoma	310	ITS 00942	12	03/15/21
BI-Log Antenna	Antenna Research	CBL6111D	ITS 01505	12	03/11/21
Horn Antenna	ETS-Lindgren	3117-PA	ITS 01636	12	01/17/21
Horn Antenna	CMT	3160-10	ITS 00572	#	#
Horn Antenna	CMT	3160-09	ITS 00571	#	#
Pre-Amplifier	Miteq	TTA1840-35-S-M	ITS 01393	12	02/08/21
Notch Filter	Micro-Tronics	BRM50702	ITS 01166	12	06/11/21
Notch Filter	Micro-Tronics	BRC50703	ITS 01167	12	06/11/21
Loop Sensor	Solar Electronics	7334-1	ITS 01608	12	10/09/20
RF Cable	Megaphase	EMC1-K1K1-236	ITS 01537	12	02/20/21
RF Cable	TRU Corporation	TRU CORE 300	ITS 01330	12	06/11/21
RF Cable	TRU Corporation	TRU CORE 300	ITS 00465	12	08/16/20
RF Cable	TRU Corporation	TRU CORE 300	ITS 01470	12	08/16/20
LISN	Com-Power	LIN-115A	ITS 01285	12	07/26/20
Transient Limiter	COM-POWER	LIT-153A	ITS 01452	12	08/30/20
10m chamber	Panashield	10m Semi-Anechoic Chamber	ITS 00984	36	09/11/21

* Calibration performed by ITS prior to the test. # Calibration not required

Software used for emission compliance testing utilized the following:

Name	Manufacturer	Version	Template/Profile
BAT-EMC	Nexio	3.17.0.10	IWS Global July 2020.bpp

6.0 Document History

Revision/ Job Number	Writer Initials	Reviewer Initials	Date	Change
1.0 / G104360835	HH	KV	August 07, 2020	Original document

7. Appendix A: Evaluation for spurious emissions of pre-certified radio module installed inside the host equipment per KDB 996369 D04.

A1.0 Radiated Emissions (ANSI C63.10)

A1.1 Method

Tests are performed in accordance with ANSI C63.10, FCC 47CFR PT 15.247, FCC 47CFR PT 15.407.

TEST SITE: 10m ALSE

10m ALSE: The test facility is located at 1365 Adams Court, Menlo Park, California. The test site is a 10-meter semi-anechoic chamber. The site meets the characteristics of ANSI C63.10:2013. For measurements, a remotely controlled flush-mount metal-top turntable is used to rotate the EUT a full 360 degrees. A remote controlled non-conductive antenna mast is used to scan the antenna height from one to four meters. Above 1 GHz an antenna mast with boresight capabilities is used.

The A2LA certificate number for this site is 1755-01

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	U _{CISPR}
Radiated Emissions, 10m	30-200 MHz	4.7 dB	6.3 dB
Radiated Emissions, 10m	200-1000 MHz	4.6 dB	6.3 dB
Radiated Emissions, 3m	1-18 GHz	5.1 dB	5.2 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 32.

Sample 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 with a sample calculation is as follows:

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

Where

- FS = Field Strength in dB μ V/m
- RA = Receiver Amplitude (including preamplifier) in dB μ V
- CF = Cable Attenuation Factor in dB
- AF = Antenna Factor in dB
- AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dB μ V is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dB μ V/m. This value in dB μ V/m was converted to its corresponding level in μ V/m.

RA = 52.0 dB μ V
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dB μ V/m

To convert from dB μ V to μ V or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μ V
NF = Net Reading in dB μ V

Example:

$FS = RA + AF + CF - AG = 52.0 + 7.4 + 1.6 - 29.0 = 32.0$
 $UF = 10^{(32 \text{ dB}\mu\text{V} / 20)} = 39.8 \mu\text{V/m}$

A1.2 Test Equipment Used:

See Section 5.0 for specific equipment used for this test

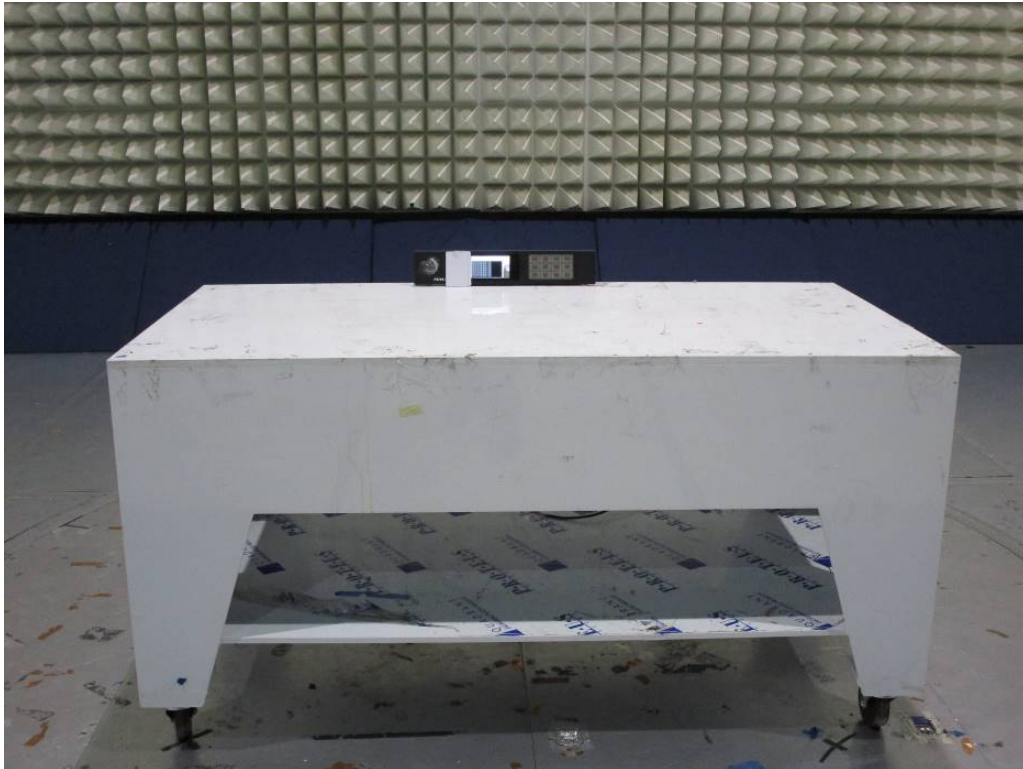
Software Utilized:

Name	Manufacturer	Version
BAT-EMC	NEXIO	3.19.1.19

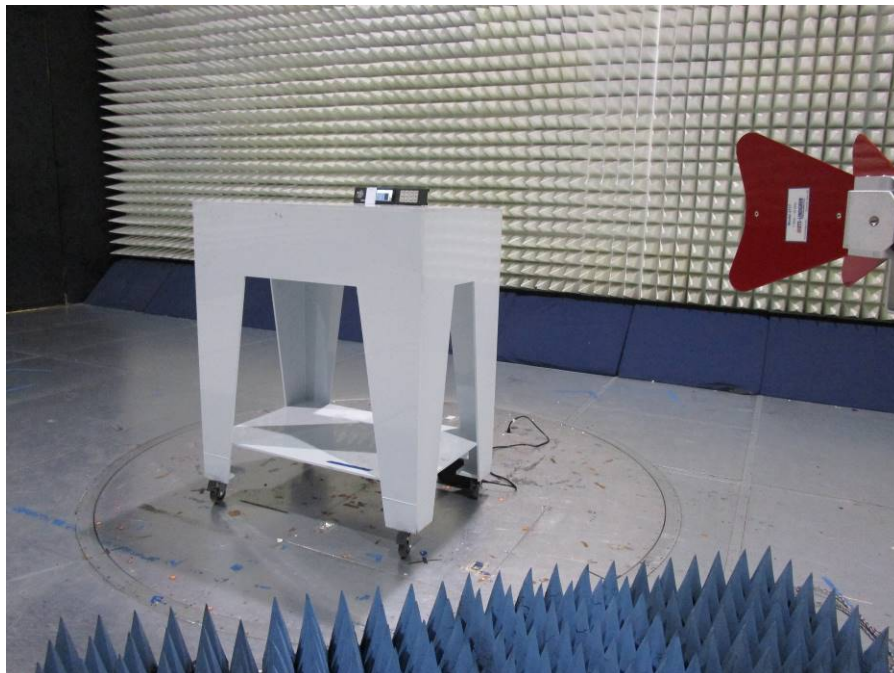
A1.3 Result:

The sample tested was found to comply.

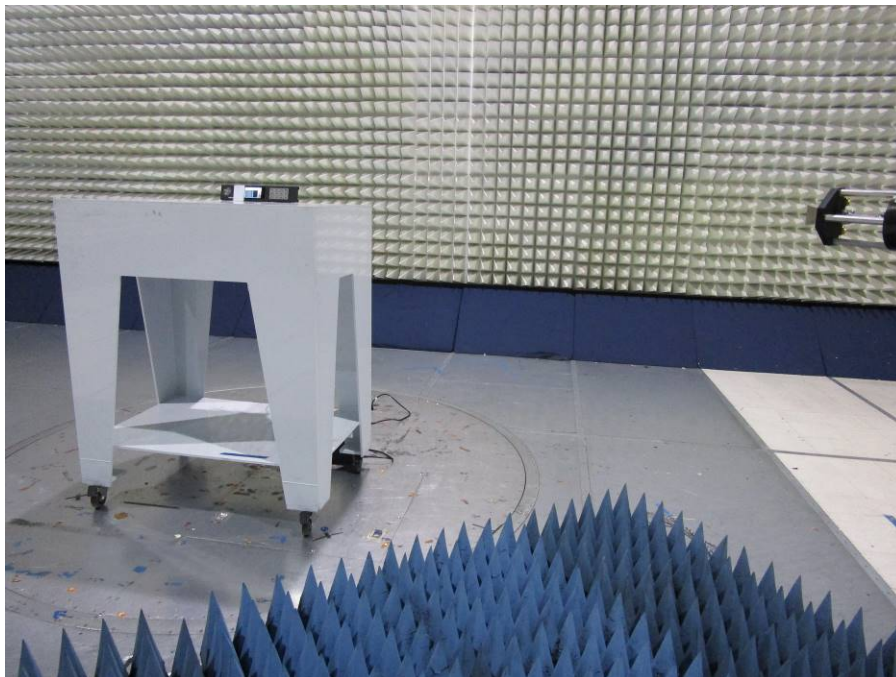
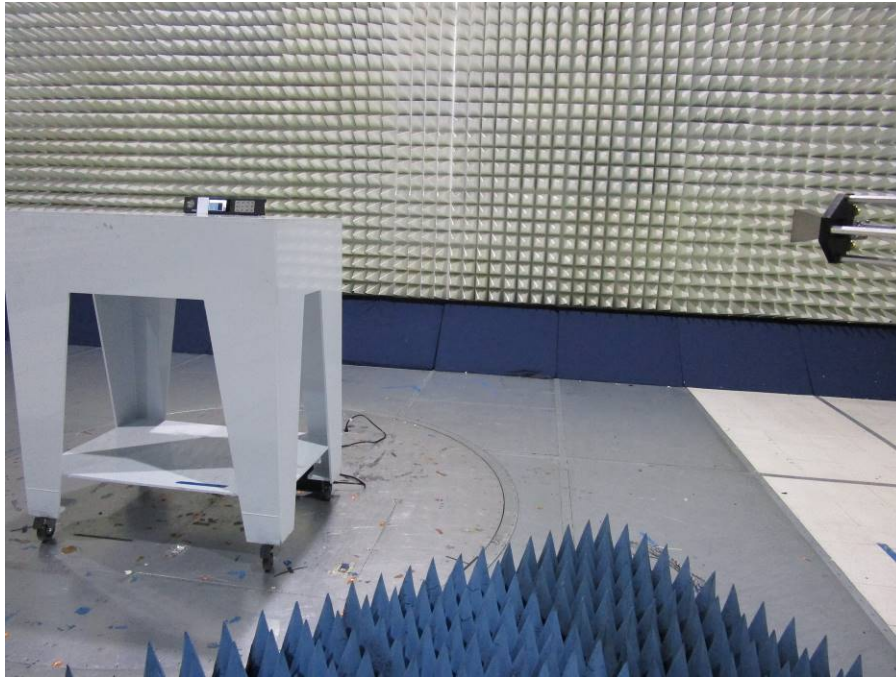
A1.4 Photographs:



A1.4 Photographs (continued):

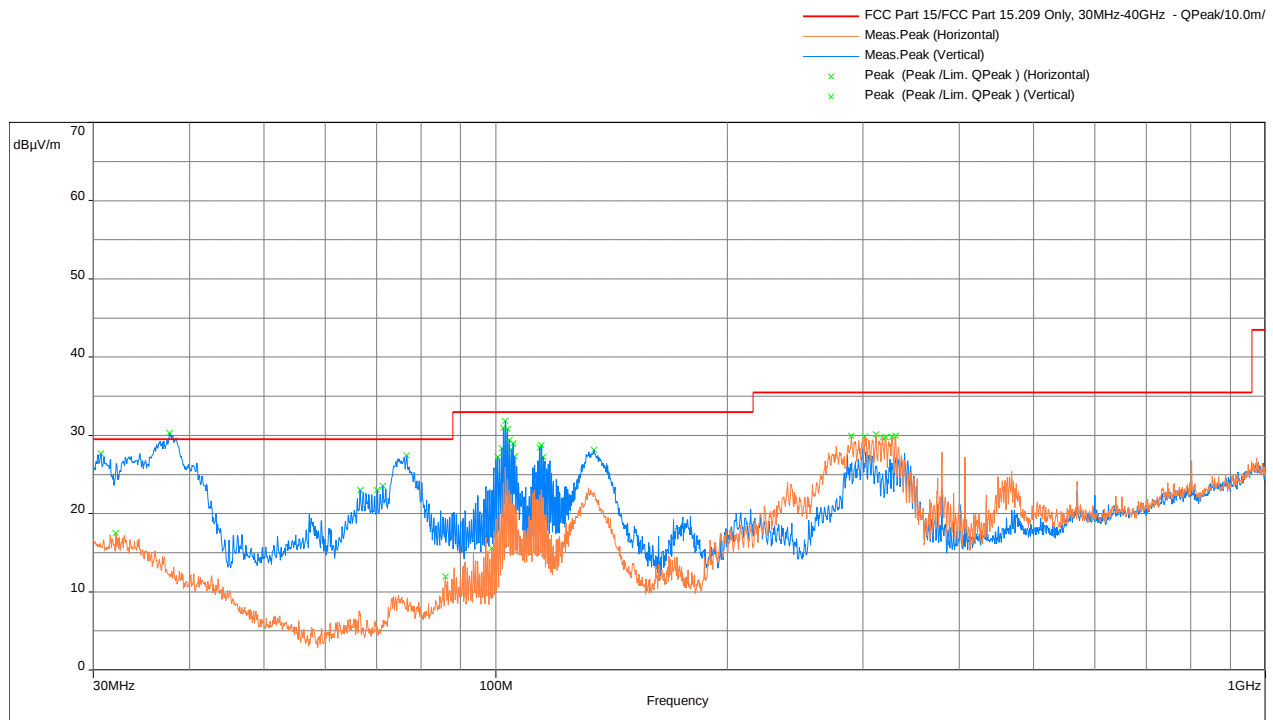


A1.4 Photographs (continued):



A1.5 Test Data for 2.4GHz BLE, WiFi 5GHz:

Radiated Spurious Emissions from 30 MHz to 1000 MHz

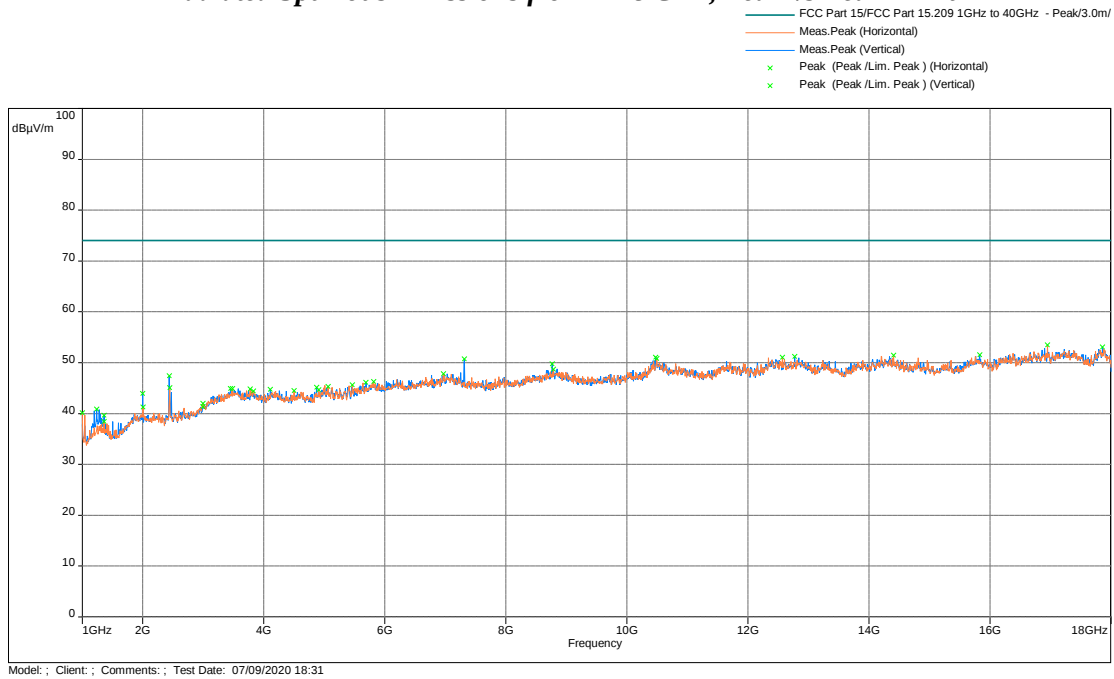


Freq (MHz)	FS @10m dB(uV/m)	Limit dB(uV/m)	Margin (dB)	Azimuth (Deg)	Height (m)	Polarity	RA@10m (dBuV)	Correction (dB)
31.02459	24.56	29.50	-4.94	157.50	1.00	Vertical	33.62	-9.23
37.78766	27.19	29.50	-2.31	297.50	1.43	Vertical	39.85	-12.72
102.9436	30.35	33.00	-2.65	216.75	1.28	Vertical	47.24	-16.89
290.0233	27.35	35.50	-8.15	191.25	2.86	Horizontal	40.72	-13.37
311.8711	27.44	35.50	-8.06	182.25	2.46	Horizontal	40.36	-12.92
330.5964	27.13	35.50	-8.37	171.50	2.81	Horizontal	39.61	-12.49

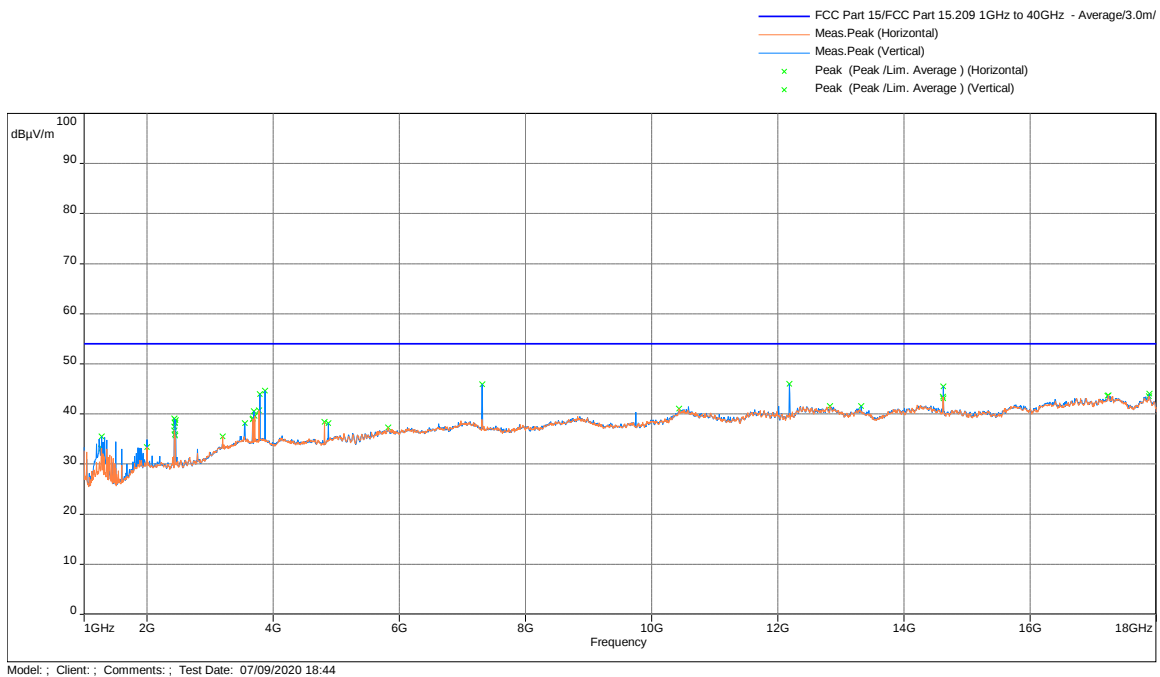
Note: FS = RA + Correction

Correction = AF + CF – Preamp

Radiated Spurious Emissions from 1-18 GHz, Peak vs Peak Limit



Radiated Spurious Emissions from 1-18 GHz, Average vs Average Limit

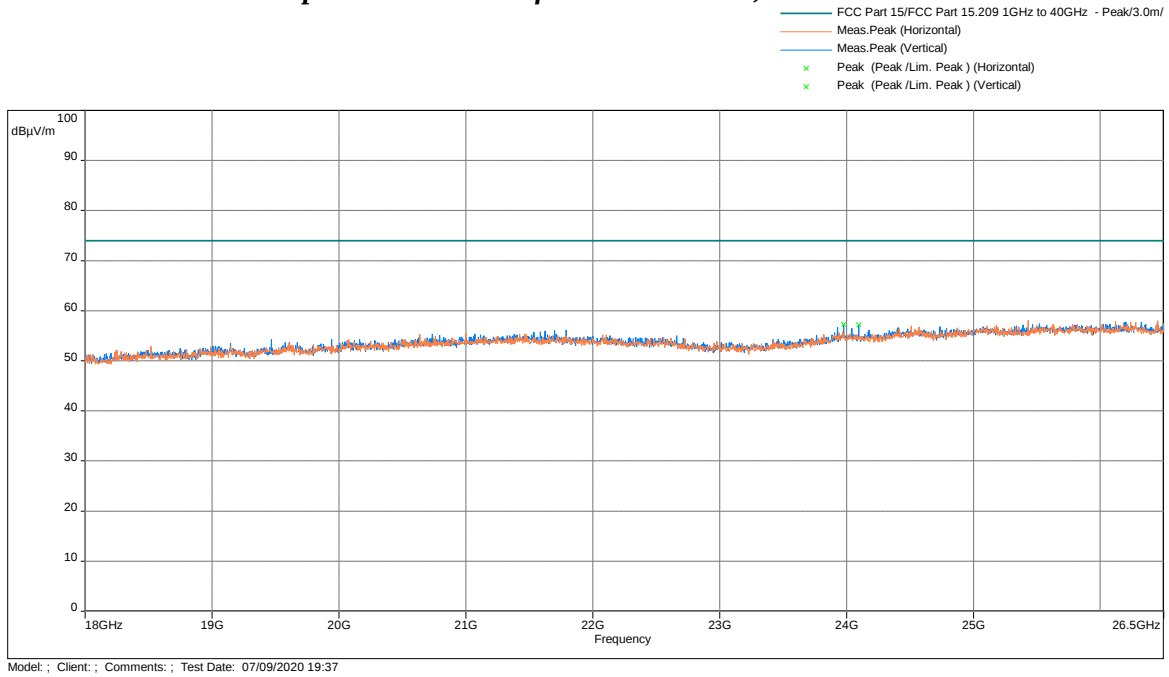


Frequency (MHz)	FS (dB μ V/m)	Ave Limit (dB μ V/m)	Ave Margin (dB)	Azimuth (deg)	Height (m)	Polarity	RA (dB μ V)	Correction (dB)
12183.73	46.03	54.00	-7.97	212.00	1.51	Vertical	46.44	0.41
7310.4	45.94	54.00	-8.06	124.25	1.73	Vertical	44.04	-1.90
14622.1	45.49	54.00	-8.51	300.75	1.80	Vertical	48.59	3.10
3869.6	44.63	54.00	-9.37	10.00	1.98	Vertical	37.18	-7.45

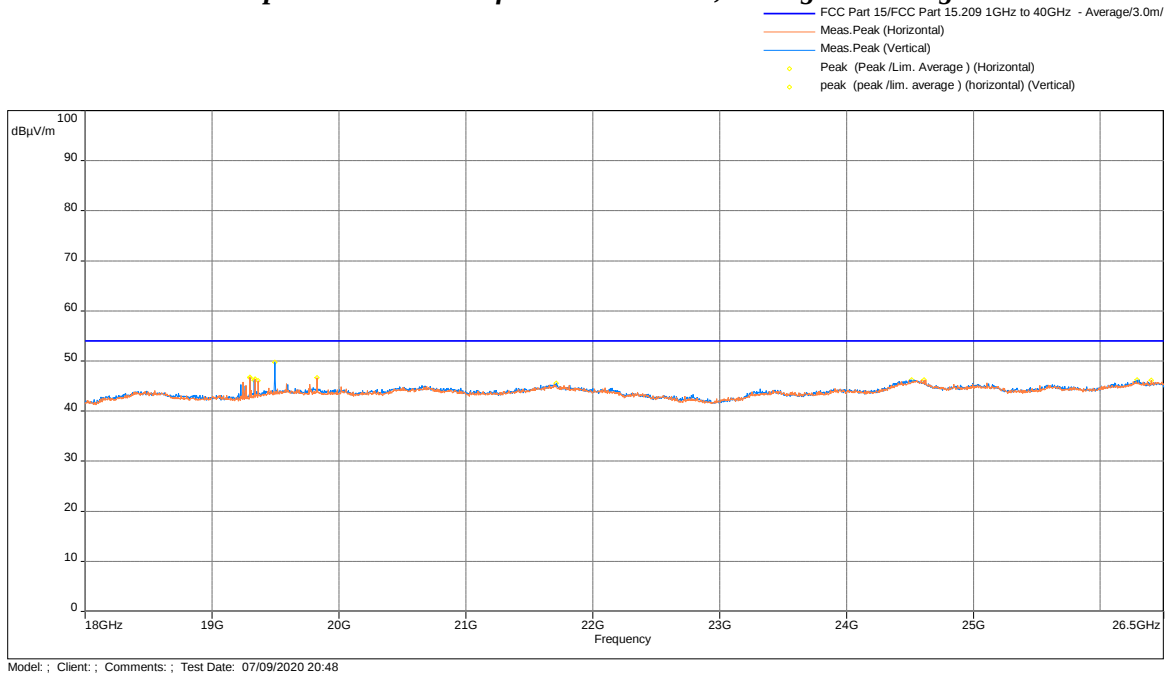
Note: FS = RA + Correction

Correction = AF + CF – Preamp

Radiated Spurious Emissions from 18-26.5 GHz, Peak vs Peak Limit



Radiated Spurious Emissions from 18-26.5 GHz, Average vs Average Limit

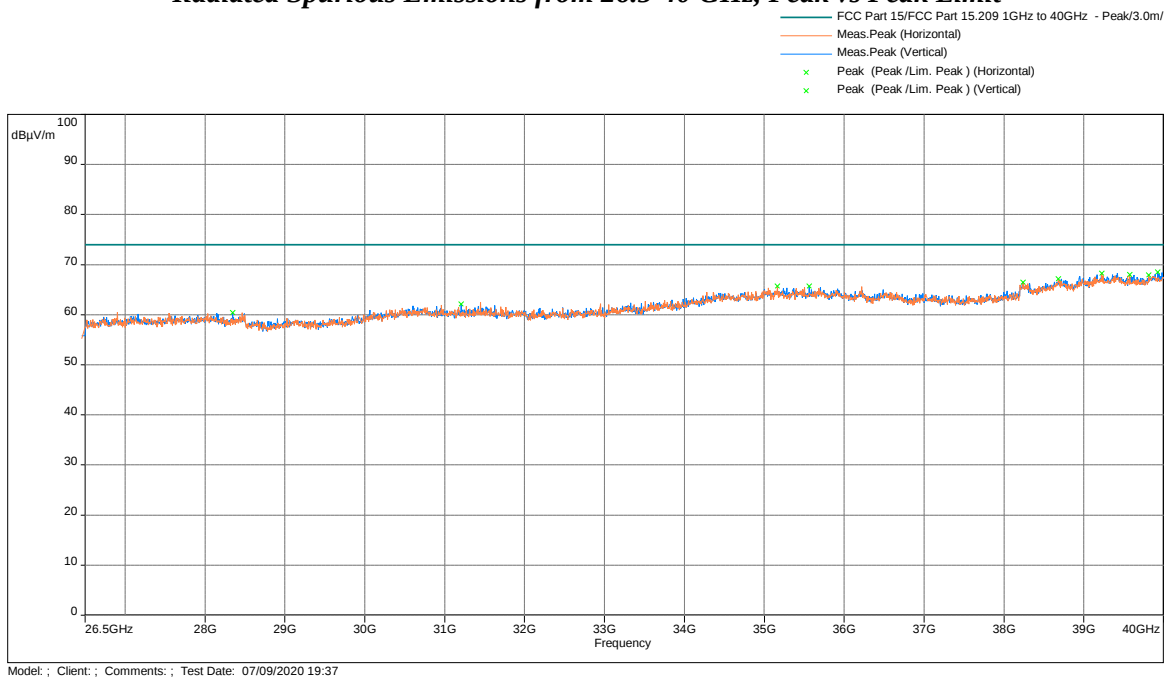


Frequency (MHz)	Peak (dBμV/m)	Lim. Average (dBμV/m)	Peak- Limit (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
19495.72	49.74	54.00	-4.26	1.98	27.00	Vertical	4.02
19299.93	46.74	54.00	-7.26	3.99	357.75	Horizontal	3.47

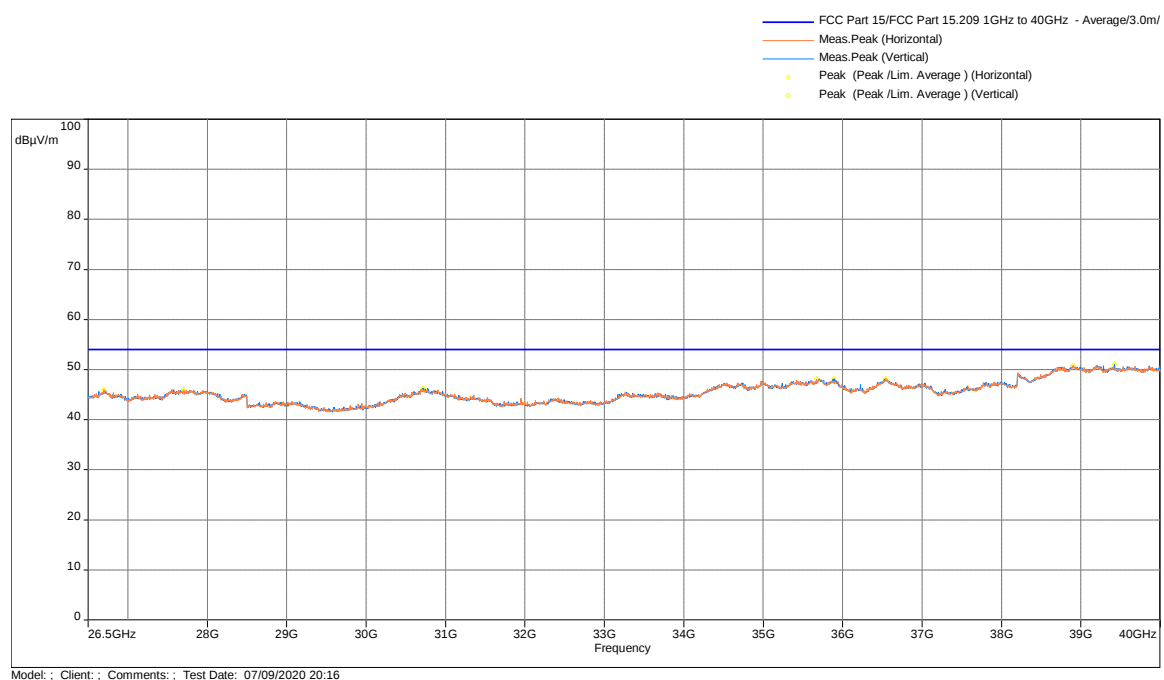
Note: FS = RA + Correction

Correction = AF + CF – Preamp

Radiated Spurious Emissions from 26.5-40 GHz, Peak vs Peak Limit



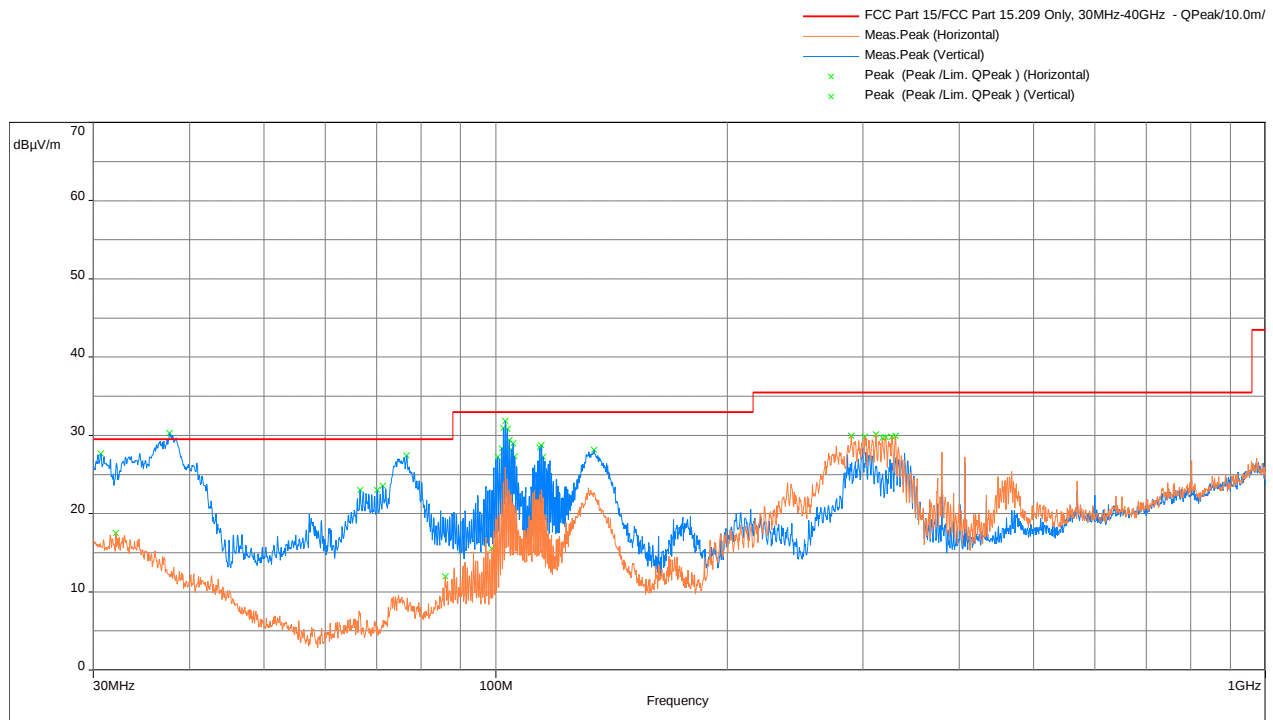
Radiated Spurious Emissions from 26.5-40 GHz, Average vs Average Limit



Result	Complies by 2.31 dB
---------------	----------------------------

A1.6 Test Data for 2.4GHz BLE, WiFi 2.4 GHz:

Radiated Spurious Emissions from 30 MHz to 1000 MHz

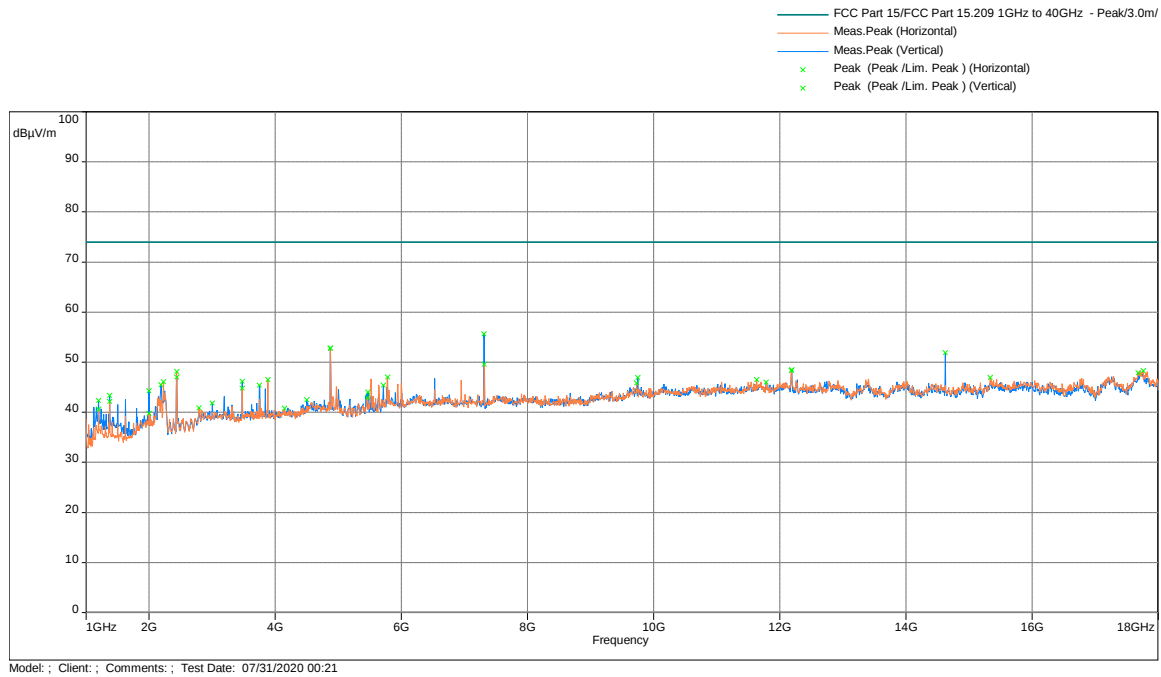


Freq (MHz)	FS @10m dB(uV/m)	Limit dB(uV/m)	Margin (dB)	Azimuth (Deg)	Height (m)	Polarity	RA@10m (dBuV)	Correction (dB)
31.02459	24.56	29.50	-4.94	157.50	1.00	Vertical	33.62	-9.23
37.78766	27.19	29.50	-2.31	297.50	1.43	Vertical	39.85	-12.72
102.9436	30.35	33.00	-2.65	216.75	1.28	Vertical	47.24	-16.89
290.0233	27.35	35.50	-8.15	191.25	2.86	Horizontal	40.72	-13.37
311.8711	27.44	35.50	-8.06	182.25	2.46	Horizontal	40.36	-12.92
330.5964	27.13	35.50	-8.37	171.50	2.81	Horizontal	39.61	-12.49

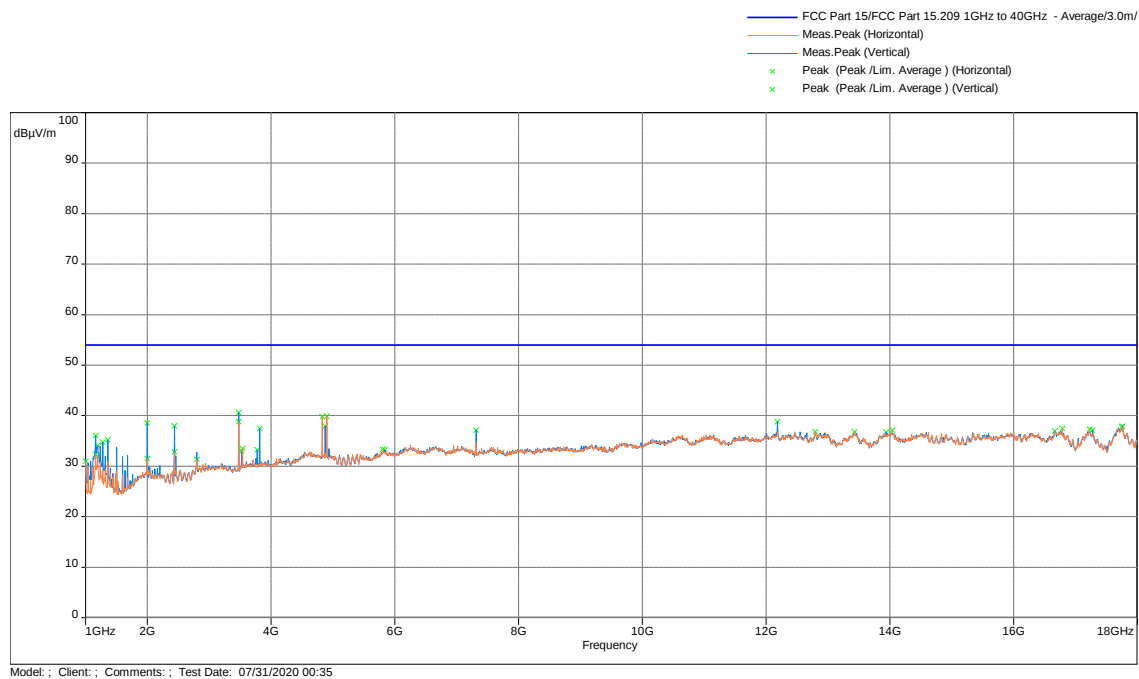
Note: FS = RA + Correction

Correction = AF + CF – Preamp

Radiated Spurious Emissions from 1-18 GHz, Peak vs Peak Limit



Radiated Spurious Emissions from 1-18 GHz, Average vs Average Limit

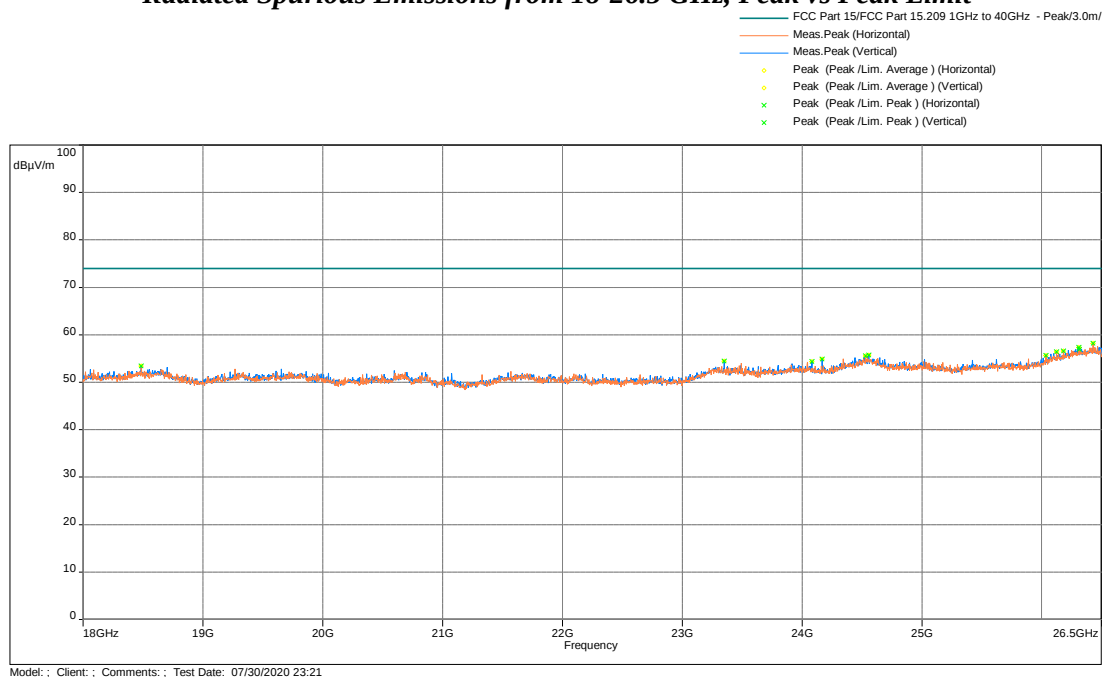


Frequency (MHz)	FS (dBμV/m)	Ave Limit (dBμV/m)	Ave Margin (dB)	Azimuth (deg)	Height (m)	Polarity	RA (dBuV)	Correction (dB)
3472.933	40.62	54	-13.38	148.50	1.51	Vertical	29.92	-10.7
4901.5	39.87	54	-14.13	281.00	1.73	Horizontal	32.33	-7.54
4822.167	39.76	54	-14.24	192.75	1.80	Horizontal	32.46	-7.3
12184.3	38.79	54	-15.21	167.00	1.98	Vertical	37.64	-1.15

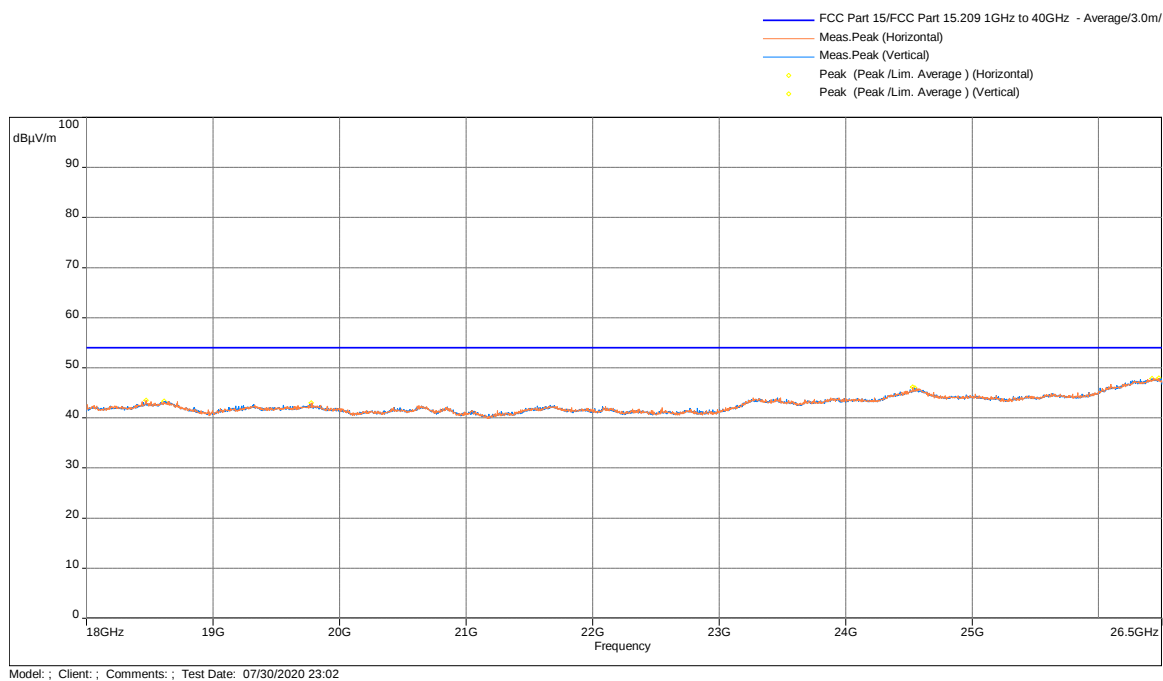
Note: FS = RA + Correction

Correction = AF + CF – Preamp

Radiated Spurious Emissions from 18-26.5 GHz, Peak vs Peak Limit



Radiated Spurious Emissions from 18-26.5 GHz, Average vs Average Limit



Result Complies by 2.31 dB

END OF REPORT