Intertek
731 Enterprise Drive
Lexington, KY 40510

Tel 859 226 1000
Fax 859 226 1040

www.intertek.com

Cubic Transportation Systems Ltd.
TEST REPORT

SCOPE OF WORK
EMC TESTING – VALIDATOR 2

REPORT NUMBER
103679095LEX-006.1

ISSUE DATE	**REVISION DATE**
1/18/2019	1/23/2019

PAGES
37

DOCUMENT CONTROL NUMBER
Non-Specific EMC Report Shell Rev. December 2017

EMC TEST REPORT

(FULL COMPLIANCE)

Report Number: 103679095LEX-006.1
Project Number: G103679095

Report Issue Date: 1/23/2019

Model(s) Tested: Validator 2

Standards: Title 47 CFR Part 15.225
RSS-210 Issue 9
RSS-Gen Issue 4

Tested by:
Intertek Testing Services NA, Inc.
731 Enterprise Dr.
Lexington, KY 40510
USA

Client:
Cubic Transportation Systems Ltd.
AFC House,
Honeycrock Lane,
Salfords,
Redhill,
RH1 6LA, UK

Report prepared by

Brian Lackey, Project Engineer

Report reviewed by

Bryan Taylor, Team Leader

Table of Contents

1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 4.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

2 Test Summary

Section	Test full name	Result
6	Receiver Spurious Emissions (ANSI C63.4: 2014)	Pass
7	Transmitter Fundamental and Spurious Emissions (FCC Part 15.209, 15.225(a)-(d), RSS-210 Issue 9 § B.6(a)-(d), RSS-Gen Issue 4 § 8.9)	Pass
8	Frequency Stability (FCC Part 15.225(e), RSS-210 Issue 9 § B.6)	Pass
9	Occupied Bandwidth (RSS-Gen Issue 4 § 6.6)	Pass
10	Conducted Emissions (ANSI C63.4: 2014)	Pass
11	Antenna Requirement (FCC Part 15.203, RSS-Gen Issue 4 § 8.3)	Pass

3 Client Information

This product was tested at the request of the following:

Client Information	
Client Name:	Cubic Transportation Systems Ltd.
Address:	AFC House, Honeycrock Lane, Salfords, Redhill, RH1 6LA, UK
Contact:	Robert Johnson
Telephone:	+44 1737 786556
Email:	Robert.johnson@cubic.com
Manufacturer Information	
Manufacturer Name:	Cubic Transportation Systems Inc.
Manufacturer Address:	1308 South Washington Street, Tullahoma, TN 37388 USA

4 Description of Equipment under Test and Variant Models

Equipment Under Test	
Product Name	Validator 2
Model Number	5300-08066
Serial Number	PROT2040
Receive Date	12/4/2018
Test Start Date	12/4/2018
Test End Date	12/28/218
Device Received Condition	Good
Test Sample Type	Production
Input Rating	24Vdc via AC-DC adapter, 100V-240V, 0.8A, 50/60Hz
Number of Phases	1
Software Used By EUT	V1.12.1
Frequency Band(s)	13.56MHz
Description of Equipment Under Test (provided by client)	
The Validator 2 is intended to be used as a revenue collection device for transit operators. It is typically installed on buses or transit stations and used to “tag on” and “tag off” Contactless Smart Cards or Barcodes carried by passengers intending to pay for their journey.	

4.1 Variant Models:

There were no variant models covered by this evaluation.

5 System Setup and Method

5.1 Method:

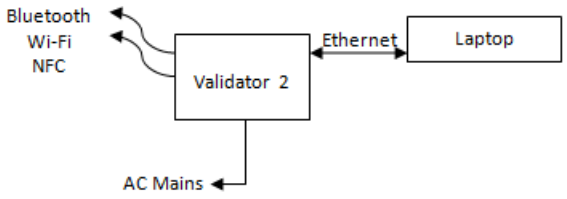
Configuration as required by ANSI C63.4: 2014 and ANSI C63.10:2013.

No.	Descriptions of EUT Exercising
1	Transmitting an NFC signal at 13.56MHz

Cables					
ID	Description	Length (m)	Shielding	Ferrites	Termination
1	AC-DC Power	2	No	No	Plug
2	Ethernet	10	No	No	USB

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
Laptop	HP	-	-

5.2 EUT Block Diagram:



5.3 EUT Photo (Front):

5.4 EUT Photo (Back):

6 Receiver Spurious Emissions

6.1 Test Method

Tests are performed in accordance with ANSI C63.4: 2014

TEST SITE: 10m ALSE

Site Designation: 10m Chamber

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	3.9dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	4.0dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.7dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	4.7dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	4.7dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	4.7dB	5.5 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.

6.2 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 dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
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 dBμV 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 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

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

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

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

6.3 Test Equipment Used

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	3900	Rohde & Schwarz	ESU40	9/18/2018	9/18/2019
Bilog Antenna	7088	SunAR	JB6	7/24/2018	7/24/2019
System Controller	4096	ETS Lindgren	2090	Verify at Time of Use	Verify at Time of Use
System Controller	3957	Sunol Sciences	SC99V	Verify at Time of Use	Verify at Time of Use
3m Cable Chamber→Control Room	2593			11/26/2018	11/26/2019
3m Cable Control Room→Receiver	2592			11/26/2018	11/26/2019
10m Cable Antenna→Preamp	3339			11/26/2018	11/26/2019

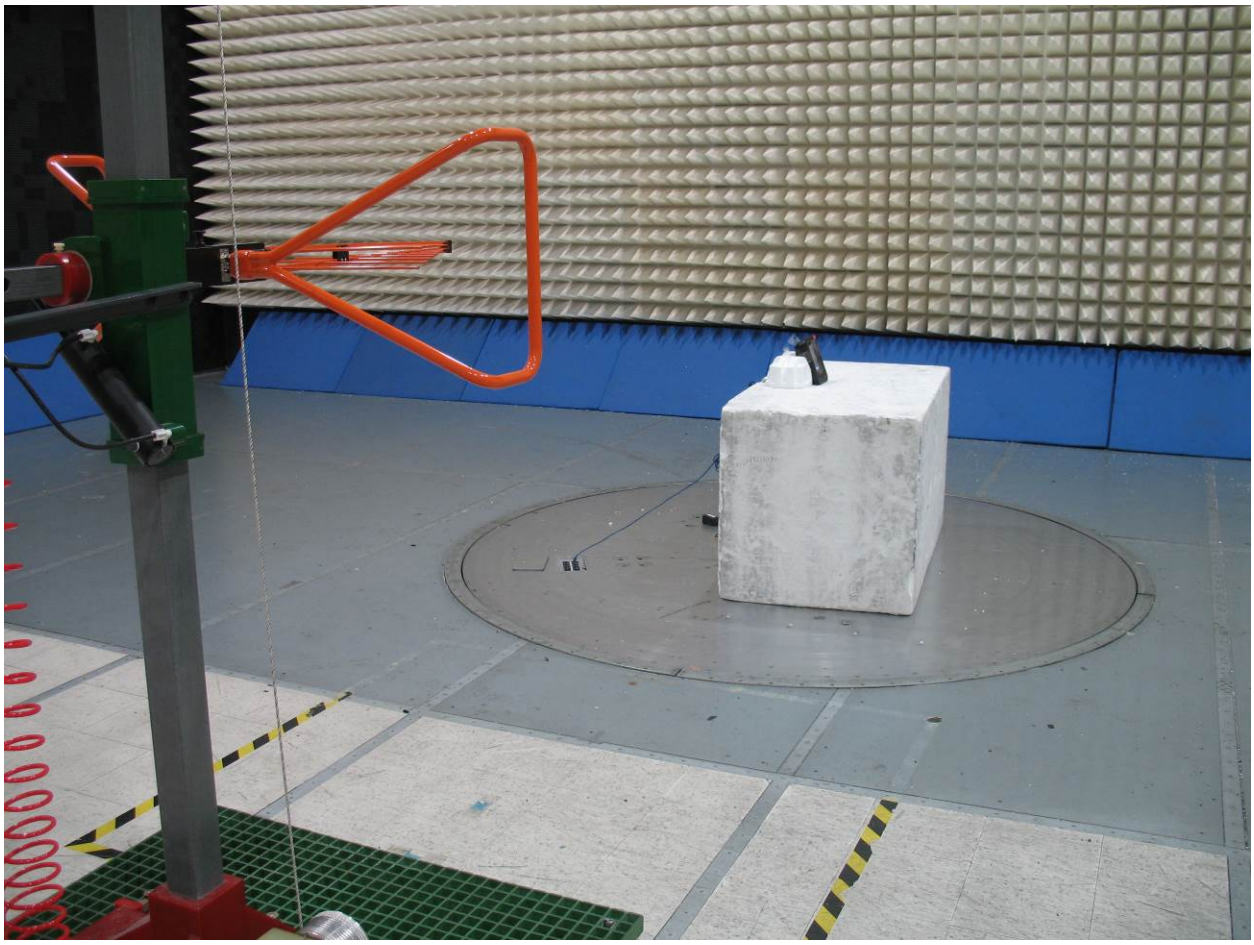
6.4 Software Utilized

Name	Manufacturer	Version
EMC32	Rohde & Schwarz	Version 9.15.02

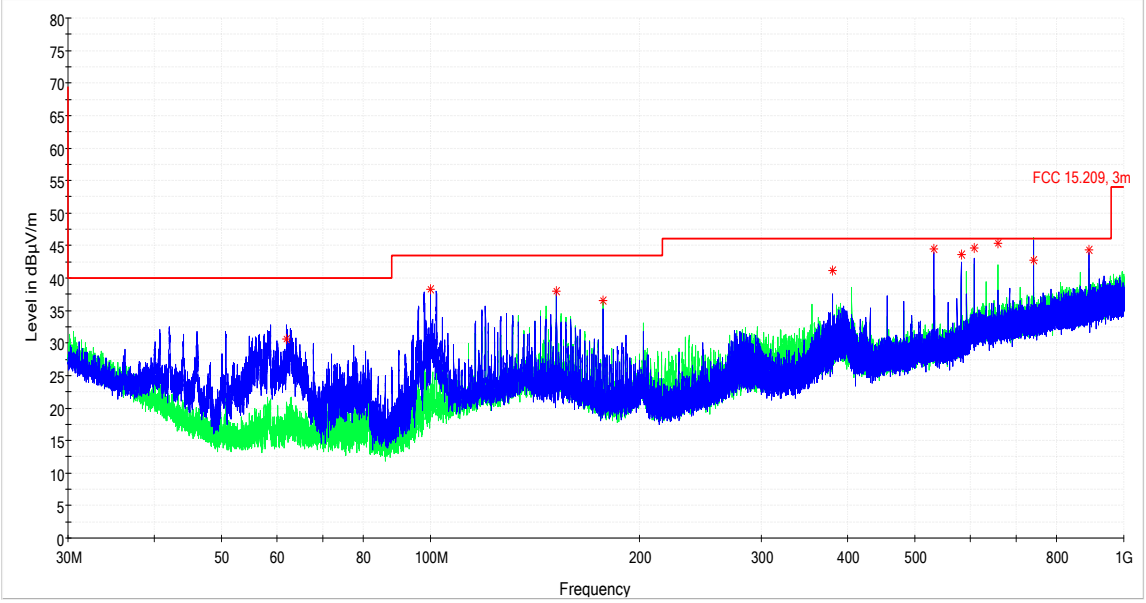
6.5 Test Results

The sample tested was found to be **compliant**.

6.6 Setup Photographs: 30MHz – 1GHz



6.7 Test Data: 30MHz – 1GHz



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
61.983000	30.62	40.00	9.38	120.000	100.0	V	92.0	14.7
100.000000	38.30	43.52	5.22	120.000	100.2	V	18.0	18.9
151.980000	37.96	43.52	5.56	120.000	100.0	V	0.0	21.2
177.320000	36.54	43.52	6.98	120.000	156.3	H	92.0	19.9
380.020000	41.15	46.02	4.87	120.000	129.7	V	264.0	24.9
532.010000	44.51	46.02	1.51	120.000	100.0	V	0.0	28.2
582.650000	43.66	46.02	2.36	120.000	100.1	V	108.0	29.0
608.000000	44.55	46.02	1.47	120.000	100.0	V	91.0	29.5
658.670000	45.38	46.02	0.64	120.000	106.8	H	184.0	30.9
741.800000	42.80	46.02	3.22	120.000	129.3	H	8.0	31.8
890.100000	44.27	46.02	1.75	120.000	212.4	V	8.0	33.5

Test Personnel:	Ben Coolbear	Test Date:	12/27/2018
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	See Above
Product Standard:	FCC Part 15.225 RSS-210 Issue 9	Ambient Temperature:	21.7C
Input Voltage:	120V/60Hz	Relative Humidity:	22.6%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	985.4mbar

Deviations, Additions, or Exclusions: None

7 Transmitter Fundamental and Spurious Emissions

7.1 Test Limits

FCC Part 15.225:

(a) The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter 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.

FCC Part 15.209:

(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

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

RSS-210 Issue 9 § B.6:

The field strength of any emission shall not exceed the following limits:

1. 15.848 mV/m (84 dBµV/m) at 30 m, within the band 13.553-13.567 MHz;
2. 334 µV/m (50.5 dBµV/m) at 30 m, within the bands 13.410-13.553 MHz and 13.567-13.710 MHz;
3. 106 µV/m (40.5 dBµV/m) at 30 m, within the bands 13.110-13.410 MHz and 13.710-14.010 MHz; and
4. RSS-Gen general field strength limits for frequencies outside the band 13.110-14.010 MHz.

RSS-Gen Issue 4 § 8.9:

Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in Table 4 and Table 5 below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

Table 4 – General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Above 30 MHz

Frequency (MHz)	Field Strength (µv/m at 3 metres
30-88	100
88-216	150
216-960	200
Above 960*	500

Table 5 – General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Below 30 MHz

Frequency	Electric Field Strength (µV/m)	Magnetic Field Strength (H-Field) (µA/m)	Measurement Distance (metres)
9-490 kHz	2,400/F (F in kHz)	2,400/377F (F in kHz)	300
490-1,705 kHz	24,000/F (F in kHz)	24,000/377F (F in kHz)	30
1,705-30 MHz	30	N/A	30

7.2 Test Method

Tests are performed in accordance with ANSI C63.10:2013.

TEST SITE: 10m ALSE

Site Designation: 10m Chamber

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	3.9dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	4.0dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.7dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	4.7dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	4.7dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	4.7dB	5.5 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.

7.3 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 dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
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 dBμV 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 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
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CF = 1.6 dB
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FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

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

7.4 Test Equipment Used

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	3900	Rohde & Schwarz	ESU40	9/18/2018	9/18/2019
Bilog Antenna	7088	SunAR	JB6	7/24/2018	7/24/2019
Loop Antenna	2387	EMCO	6511	6/7/2018	6/7/2019
System Controller	4096	ETS Lindgren	2090	Verify at Time of Use	Verify at Time of Use
System Controller	3957	Sunol Sciences	SC99V	Verify at Time of Use	Verify at Time of Use
3m Cable Chamber→Control Room	2593			11/26/2018	11/26/2019
3m Cable Control Room→Receiver	2592			11/26/2018	11/26/2019
10m Cable Antenna→Preamp	3339			11/26/2018	11/26/2019

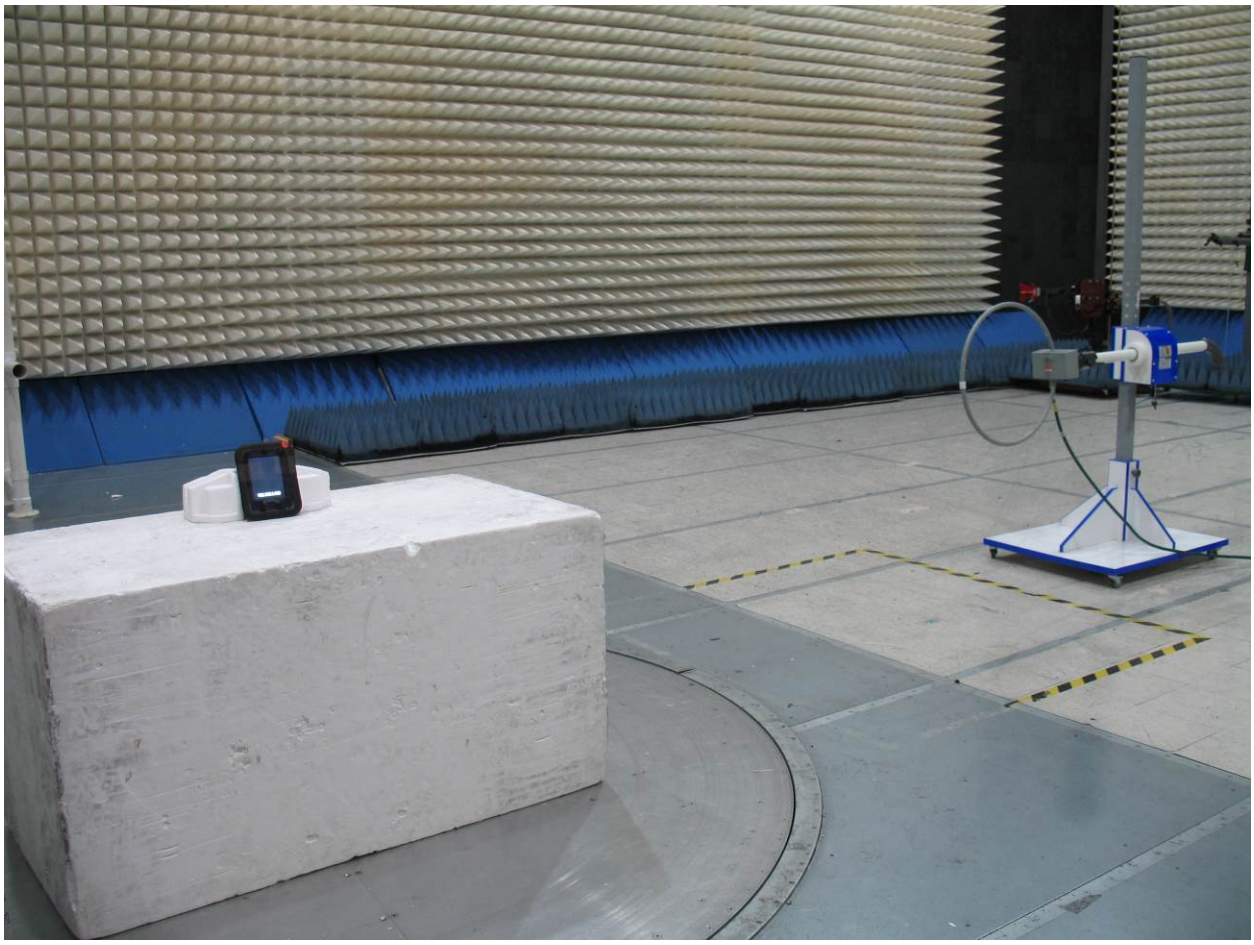
7.5 Software Utilized

Name	Manufacturer	Version
EMC32	Rohde & Schwarz	Version 9.15.02

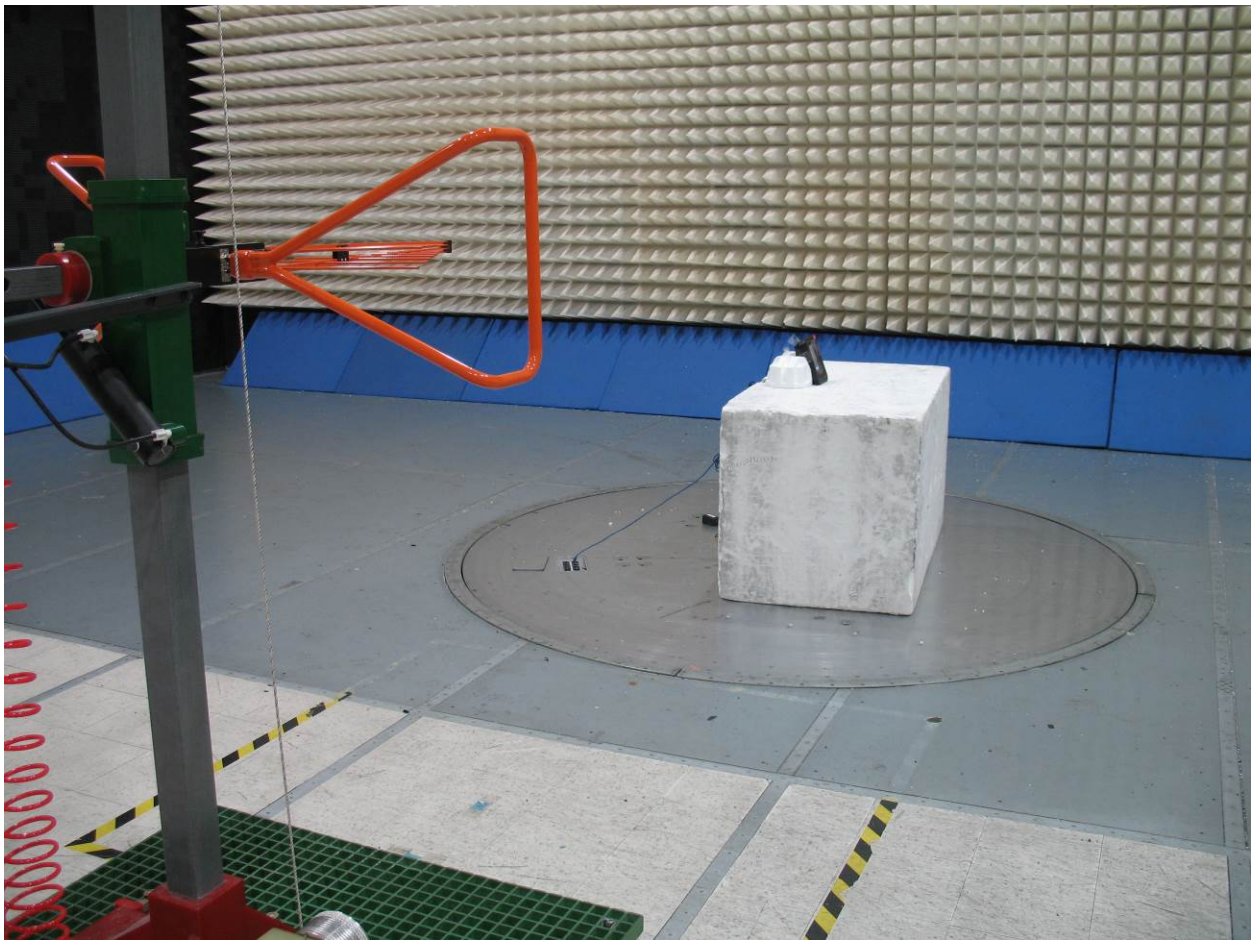
7.6 Test Results

The sample tested was found to be **compliant**.

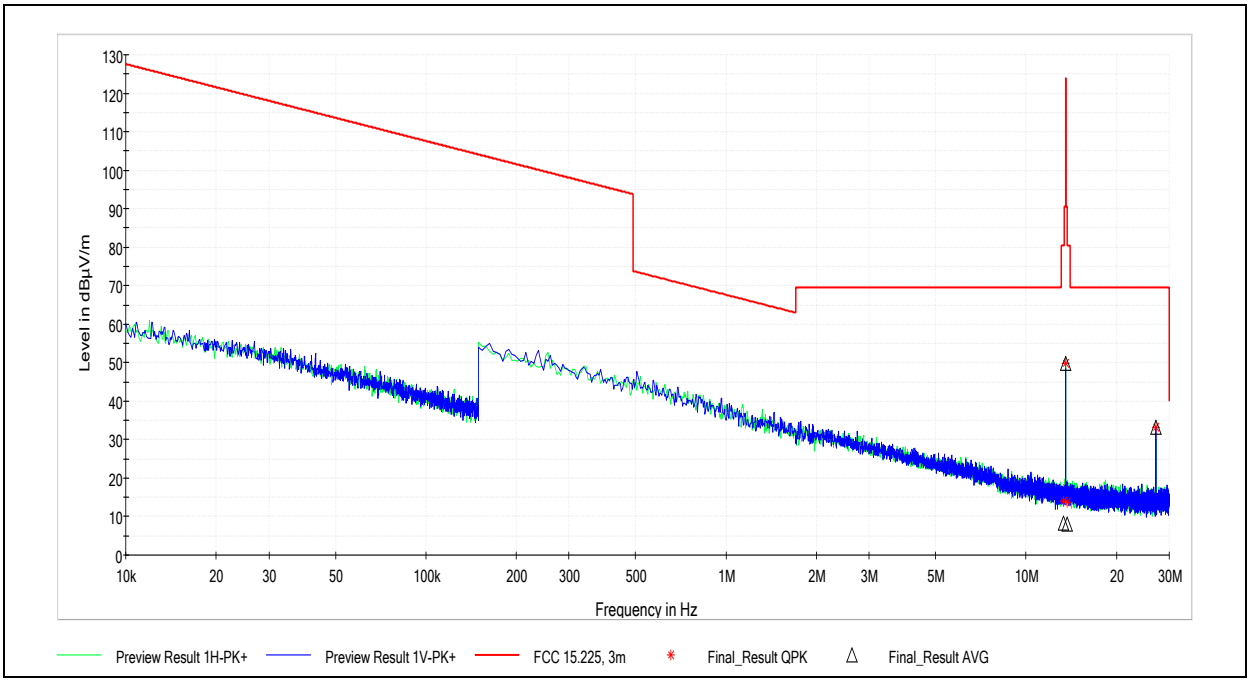
7.7 Setup Photographs: 10kHz – 30MHz



7.8 Setup Photographs: 30MHz – 1GHz



7.9 Test Data: 10kHz – 30MHz



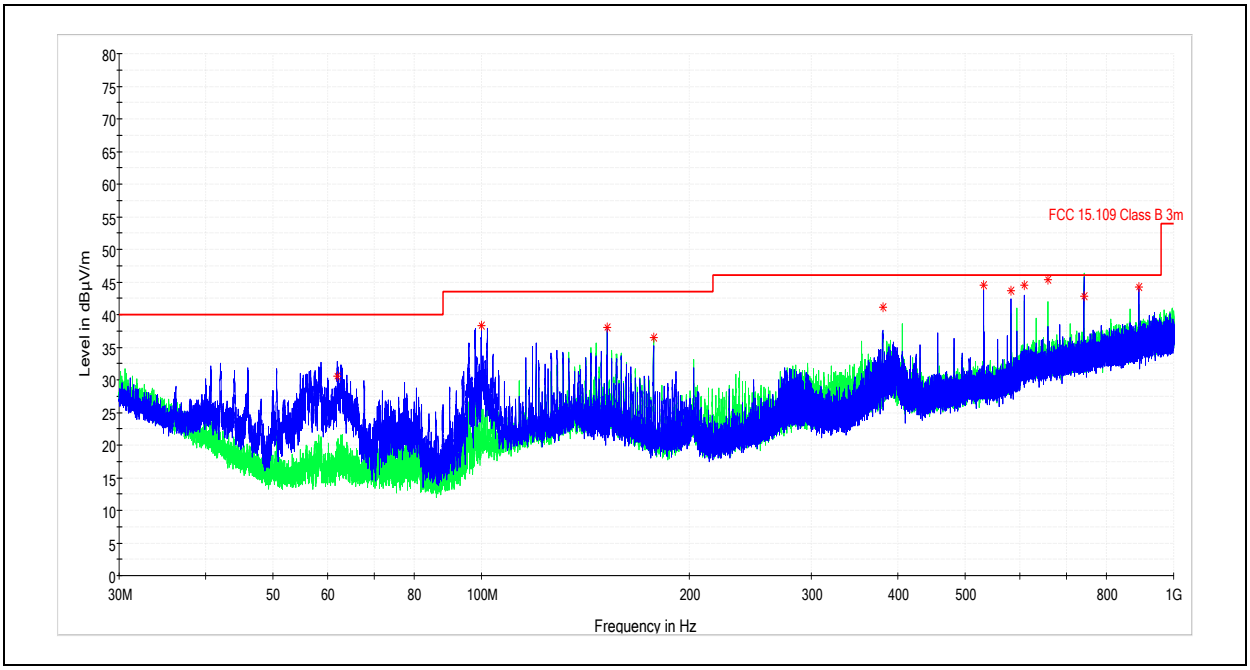
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Azimuth (deg)	Corr. (dB)
0.632868	39.93	71.58	31.65	9.000	22.0	12.6
13.354235	42.17	80.50	38.33	9.000	92.0	11.5
13.437640	49.46	90.50	41.04	9.000	177.0	11.5
13.551772	67.91	90.50	22.59	9.000	0.0	11.5
13.560552	86.33	124.00	37.67	9.000	0.0	11.5
13.569331	59.27	90.50	31.23	9.000	0.0	11.5
13.626397	45.51	90.50	44.99	9.000	92.0	11.5
13.771257	54.10	80.50	26.40	9.000	174.0	11.5
24.003662	28.61	69.50	40.89	9.000	24.0	10.3
26.000978	25.79	69.50	43.71	9.000	42.0	9.9
27.159860	19.93	69.50	49.57	9.000	24.0	9.7

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Azimuth (deg)	Corr. (dB)
0.632868	34.17	71.58	37.41	9.000	22.0	12.6
13.354235	15.98	80.50	64.52	9.000	92.0	11.5
13.437640	22.61	90.50	67.89	9.000	177.0	11.5
13.551772	67.88	90.50	22.62	9.000	0.0	11.5
13.560552	86.29	124.00	37.71	9.000	0.0	11.5
13.569331	59.17	90.50	31.33	9.000	0.0	11.5
13.626397	20.29	90.50	70.21	9.000	92.0	11.5
13.771257	21.95	80.50	58.55	9.000	174.0	11.5
24.003662	26.93	69.50	42.57	9.000	24.0	10.3
26.000978	22.46	69.50	47.04	9.000	42.0	9.9
27.159860	14.58	69.50	54.92	9.000	24.0	9.7

Test Personnel:	Brian Lackey	Test Date:	12/27/2018
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	See Above
Product Standard:	FCC Part 15.255 RSS-210 Issue 9	Ambient Temperature:	21.7C
Input Voltage:	120V/60Hz	Relative Humidity:	22.6%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	985.4mbar

Deviations, Additions, or Exclusions: Limits were adjusted for testing at 3m by 40dB/decade per FCC Part 15.31(f)(2). The field strength of the fundamental and all spurious emisisons was below the limits in FCC Part 15.209.

7.10 Test Data: 30MHz – 1GHz



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
61.983000	30.62	40.00	9.38	120.000	100.0	V	92.0	14.7
100.000000	38.30	43.52	5.22	120.000	100.2	V	18.0	18.9
151.980000	37.96	43.52	5.56	120.000	100.0	V	0.0	21.2
177.320000	36.54	43.52	6.98	120.000	156.3	H	92.0	19.9
380.020000	41.15	46.02	4.87	120.000	129.7	V	264.0	24.9
532.010000	44.51	46.02	1.51	120.000	100.0	V	0.0	28.2
582.650000	43.66	46.02	2.36	120.000	100.1	V	108.0	29.0
608.000000	44.55	46.02	1.47	120.000	100.0	V	91.0	29.5
658.670000	45.38	46.02	0.64	120.000	106.8	H	184.0	30.9
741.800000	42.80	46.02	3.22	120.000	129.3	H	8.0	31.8
890.100000	44.27	46.02	1.75	120.000	212.4	V	8.0	33.5

Test Personnel:	Ben Coolbear	Test Date:	12/27/2018
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	See Above
Product Standard:	FCC Part 15.255 RSS-210 Issue 9	Ambient Temperature:	21.7C
Input Voltage:	120V/60Hz	Relative Humidity:	22.6%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	985.4mbar

Deviations, Additions, or Exclusions: None

8 Frequency Stability

8.1 Test Limits

FCC Part 15.225:

(e) The frequency tolerance of the carrier signal shall be maintained within ±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.

RSS-210 Issue 9 § B.6:

Carrier frequency stability shall be maintained to ±0.01% (±100 ppm).

8.2 Test Method

Tests are performed in accordance with ANSI C63.10:2013.

8.3 Test Equipment Used

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
Spectrum Analyzer	3099	Rohde & Schwarz	FSP7	9/20/2018	9/20/2019

8.4 Test Results

The sample tested was found to be **compliant**.

8.5 Test Conditions

Test Personnel:	Brian Lackey	Test Date:	12/5/2018
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	See Above
Product Standard:	FCC Part 15.255 RSS-210 Issue 9	Ambient Temperature:	21.7C
Input Voltage:	120V/60Hz	Relative Humidity:	37.1%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	985.4mbar

8.6 Test Data

Temperature (C)	Supply Voltage (V)	Frequency (MHz)	Deviation (Hz)	Deviation (%)	Limit (%)	Result
-30	120	13,559,812	-188	-0.0014	±0.01	Pass
-20	120	13,559,789	-211	-0.0016	±0.01	Pass
-10	120	13,559,790	-210	-0.0015	±0.01	Pass
0	120	13,559,792	-208	-0.0015	±0.01	Pass
10	120	13,559,794	-206	-0.0015	±0.01	Pass
20	120	13,559,760	-240	-0.0018	±0.01	Pass
30	120	13,559,763	-237	-0.0017	±0.01	Pass
40	120	13,559,772	-228	-0.0017	±0.01	Pass
50	120	13,559,771	-229	-0.0017	±0.01	Pass
20	138	13,559,768	-232	-0.0017	±0.01	Pass
20	102	13,559,771	-229	-0.0017	±0.01	Pass

Deviations, Additions, or Exclusions: None

9 Occupied Bandwidth

9.1 Test Method

Tests are performed in accordance with ANSI C63.10:2013.

9.2 Test Equipment Used

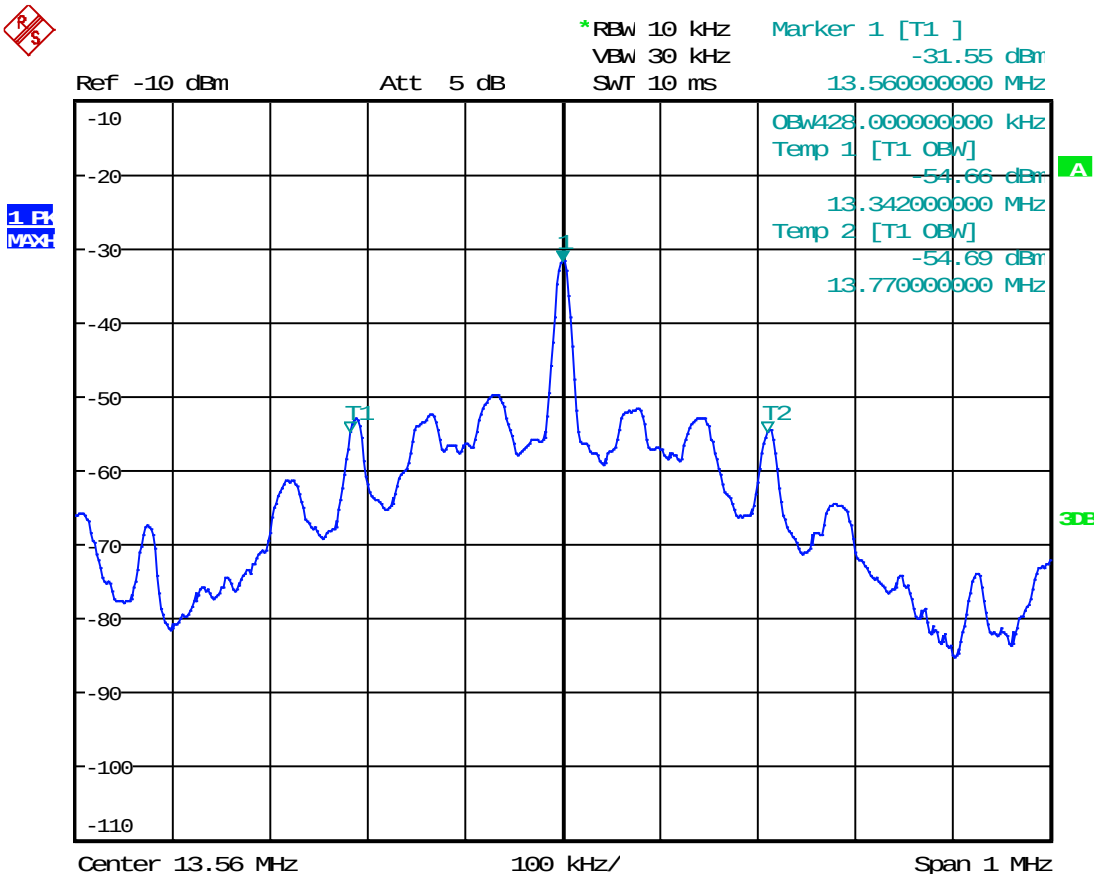
Description	Asset	Manufacturer	Model	Cal Date	Cal Due
Spectrum Analyzer	3099	Rohde & Schwarz	FSP7	9/20/2018	9/20/2019

9.3 Test Conditions

Test Personnel:	Brian Lackey	Test Date:	12/4/2018
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	See Above
Product Standard:	FCC Part 15.255 RSS-210 Issue 9	Ambient Temperature:	21.5C
Input Voltage:	120V/60Hz	Relative Humidity:	37.9%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	985.4mbar

9.4 Test Data

RBW	VBW	99% BW
10 kHz	30 kHz	428 kHz



Date: 4.DEC.2018 09:59:52

99% Occupied Bandwidth

Deviations, Additions, or Exclusions: None

10 Conducted Emissions

10.1 Method

Tests are performed in accordance with ANSI C63.4:2014.

TEST SITE: Ground Plane

Site Designation: Ground Plane

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
AC Line Conducted Emissions	150 kHz - 30 MHz	3.1dB	3.4dB
Telco Port Emissions	150 kHz - 30 MHz	3.2dB	5.0dB

As shown in the table above our conducted 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.

10.2 Sample Calculations

The following is how net line-conducted readings were determined:

NF = RF + LF + CF + AF
Where NF = Net Reading in dBµV
RF = Reading from receiver in dBµV
LF = LISN or ISN Correction Factor in dB
CF = Cable Correction Factor in dB
AF = Attenuator Loss Factor in dB

To convert from dBµV to µV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in µV
NF = Net Reading in dBµV

Example:

NF = RF + LF + CF + AF = 28.5 + 0.2 + 0.4 + 20.0 = 49.1 dBµV
$UF = 10^{(49.1\ dB\mu V / 20)}$ = 285.1 µV/m

10.3 Test Equipment Used:

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	2327	Rohde & Schwarz	ESI26	9/21/2018	9/21/2019
LISN	2509	Fischer Custom Communication	FCC-LISN-50-50-2M	4/10/2018	4/10/2019
Coaxial Cable (COND 2)	5025			11/26/2018	11/26/2019

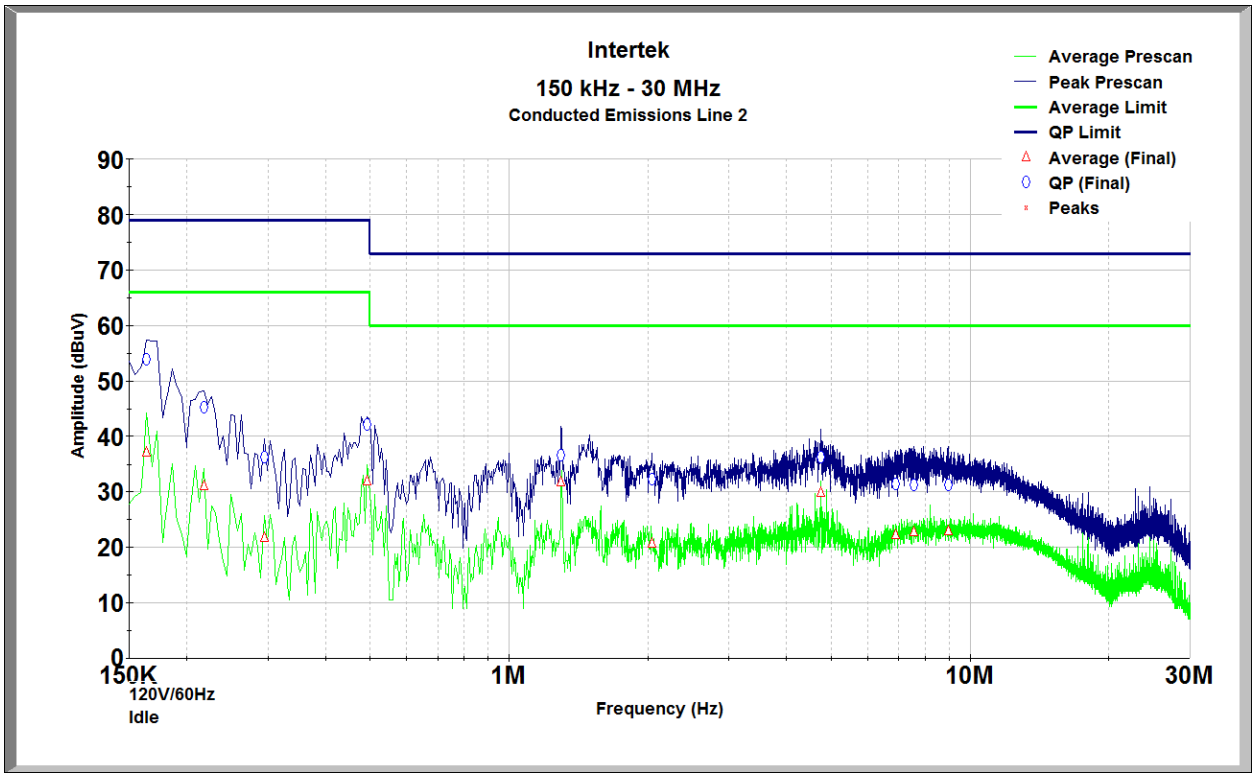
10.4 Software Utilized:

Name	Manufacturer	Version
TILE	ETS Lindgren	V7.0.6.545

10.5 Results:

The sample tested was found to Comply.

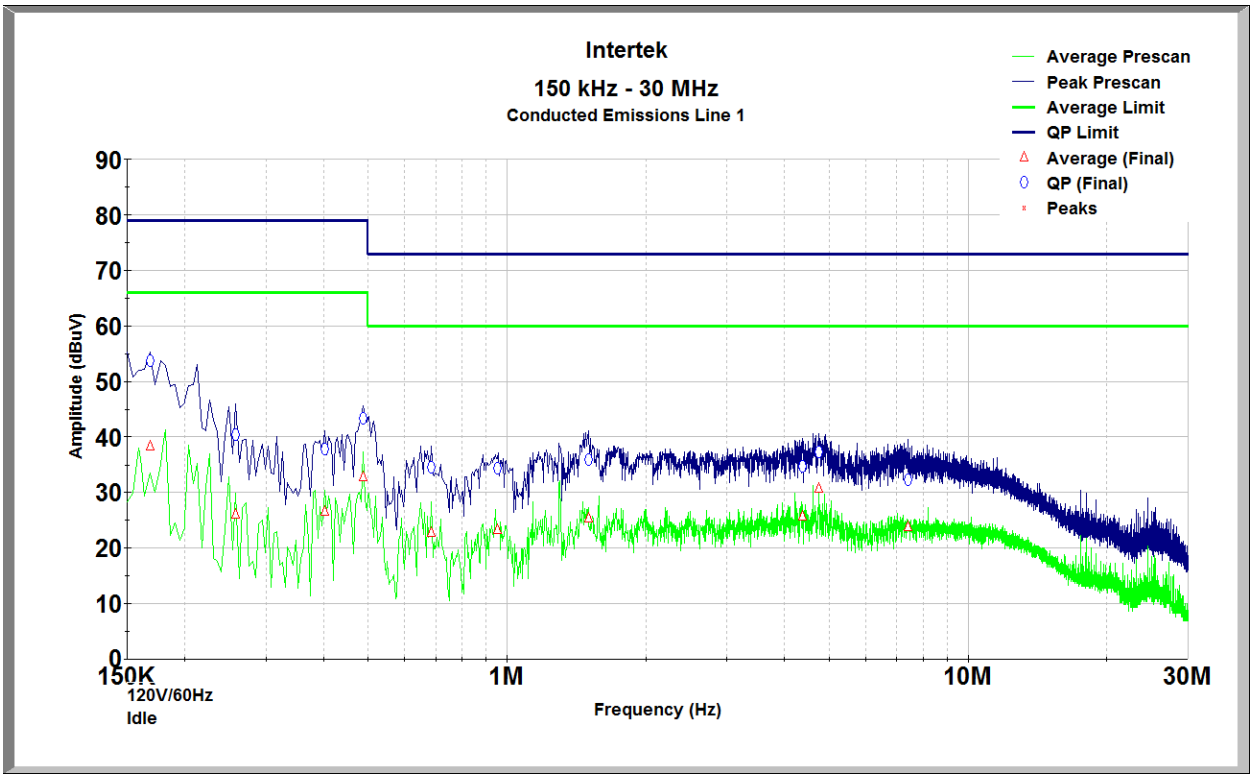
10.6 Plots/Data: Conducted Emissions (Idle)



Line

Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
0.168	53.801	79.000	25.199	38.307	66.000	27.693
0.258	40.414	79.000	38.586	25.980	66.000	40.020
0.402	37.882	79.000	41.118	26.591	66.000	39.409
0.487	43.331	79.000	35.669	32.729	66.000	33.271
0.686	34.582	73.000	38.418	22.864	60.000	37.136
0.956	34.284	73.000	38.716	23.360	60.000	36.640
1.504	35.997	73.000	37.003	25.419	60.000	34.581
4.371	34.663	73.000	38.337	25.736	60.000	34.264
4.749	37.343	73.000	35.657	30.638	60.000	29.362
7.395	32.346	73.000	40.654	23.882	60.000	36.118

Line



Neutral

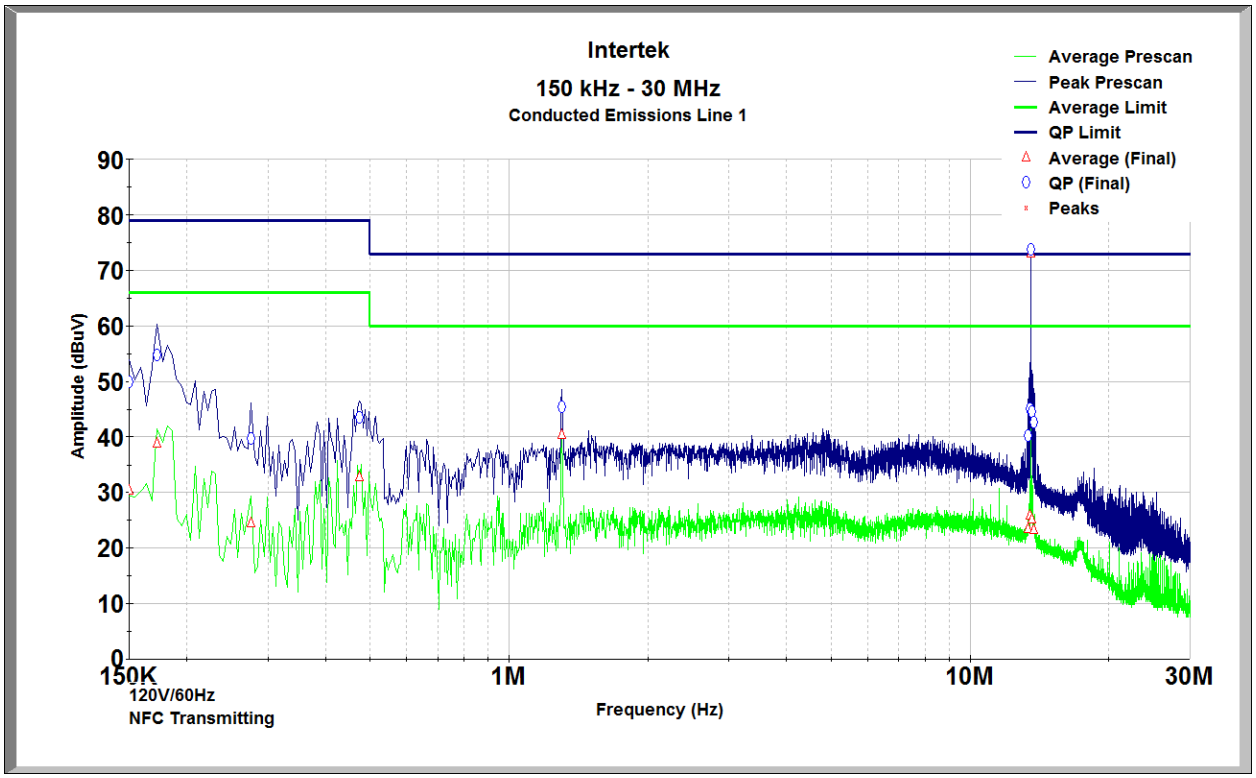
Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
0.164	53.881	79.000	25.119	37.084	66.000	28.916
0.218	45.327	79.000	33.673	31.020	66.000	34.980
0.294	36.234	79.000	42.766	21.703	66.000	44.297
0.492	42.091	79.000	36.909	31.936	66.000	34.064
1.298	36.632	73.000	36.368	31.775	60.000	28.225
2.040	32.324	73.000	40.676	20.686	60.000	39.314
4.753	36.298	73.000	36.702	29.940	60.000	30.060
6.900	31.397	73.000	41.603	22.302	60.000	37.698
7.543	31.316	73.000	41.684	22.766	60.000	37.234
8.972	31.206	73.000	41.794	23.036	60.000	36.964

Neutral

Test Personnel:	Brian Lackey	Test Date:	12/4/2018
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class A
Product Standard:	FCC Part 15B ICES-003 Issue 6	Ambient Temperature:	21.5C
Input Voltage:	120V/60Hz	Relative Humidity:	37.9%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	985.4mbar

Deviations, Additions, or Exclusions: None

10.7 Plots/Data: Conducted Emissions - NFC Transmitting, Antenna Attached

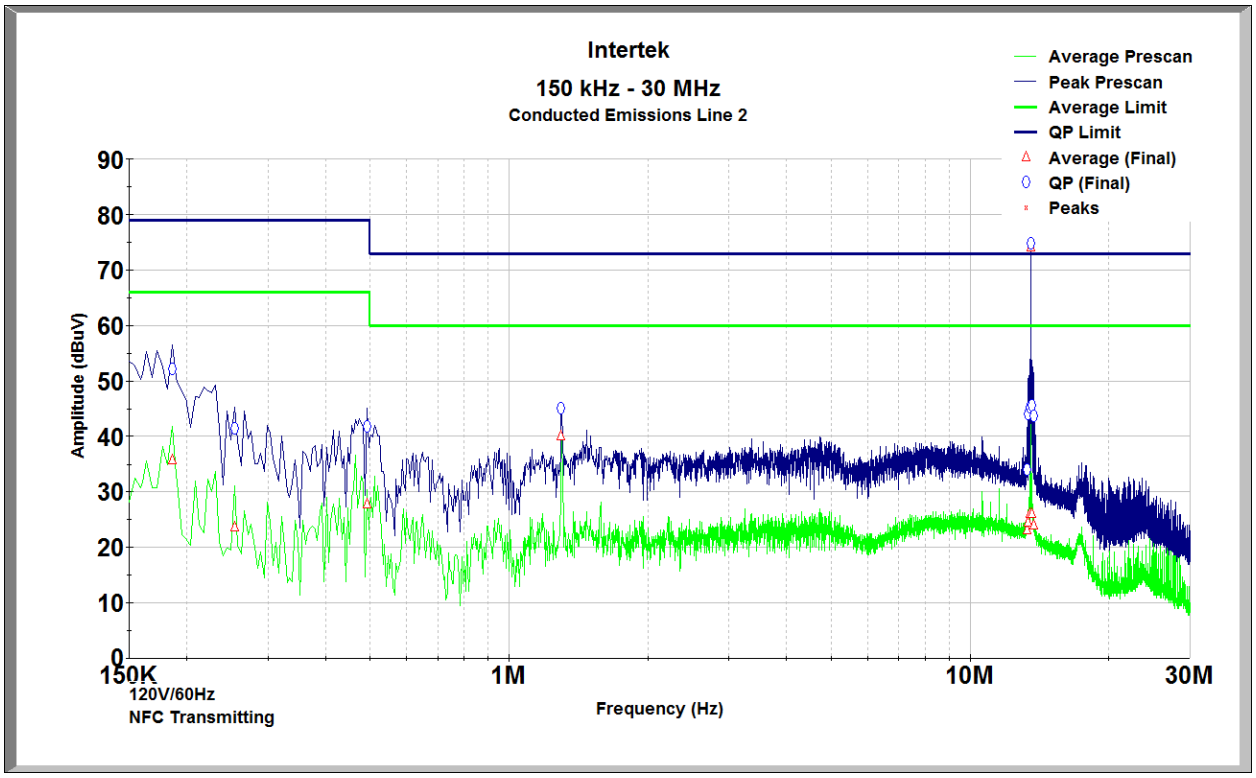


Line

Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
0.150	49.935	66.000	16.065	30.304	56.000	25.696
0.172	54.721	65.357	10.636	38.851	55.357	16.506
0.276	39.761	62.400	22.639	24.572	52.400	27.828
0.474	43.496	56.743	13.247	32.773	46.743	13.970
1.302	45.360	56.000	10.640	40.342	46.000	5.658
13.355	40.147	60.000	19.853	23.508	50.000	26.492
13.490	45.155	60.000	14.845	25.895	50.000	24.105
13.562[1]	73.755	60.000	-13.755	73.055	50.000	-23.055
13.634	44.582	60.000	15.418	25.241	50.000	24.759
13.769	42.670	60.000	17.330	23.335	50.000	26.665

Line

[1] Fundamental emission of intentional 13.56MHz radio



Neutral

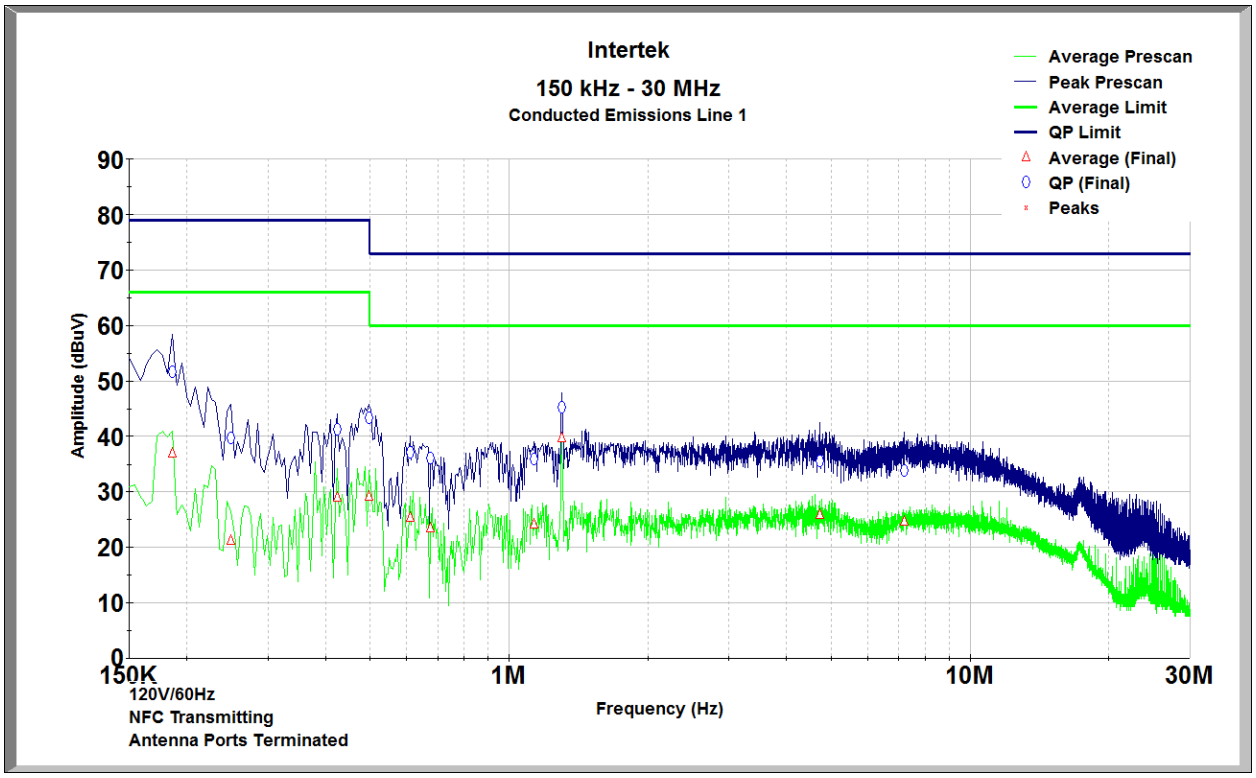
Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
0.186	52.247	64.971	12.725	35.697	54.971	19.275
0.254	41.433	63.043	21.609	23.676	53.043	29.367
0.492	41.799	56.229	14.430	27.770	46.229	18.458
1.298	45.038	56.000	10.962	40.126	46.000	5.874
13.278	33.961	60.000	26.039	23.197	50.000	26.803
13.345	44.025	60.000	15.975	24.561	50.000	25.439
13.480	45.207	60.000	14.793	26.011	50.000	23.989
13.562[1]	74.823	60.000	-14.823	74.165	50.000	-24.165
13.634	45.646	60.000	14.354	26.051	50.000	23.949
13.769	43.692	60.000	16.308	24.074	50.000	25.926

Neutral

Test Personnel:	Brian Lackey	Test Date:	12/28/2018
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class A
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	22.3C
Input Voltage:	120V/60Hz	Relative Humidity:	43.9%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	982.0mbar

Deviations, Additions, or Exclusions: Per FCC Publication Number 174176, the device was tested with its antenna attached, then again with the antenna replaced by a suitable dummy load to determine compliance within the transmitter's fundamental emission band.

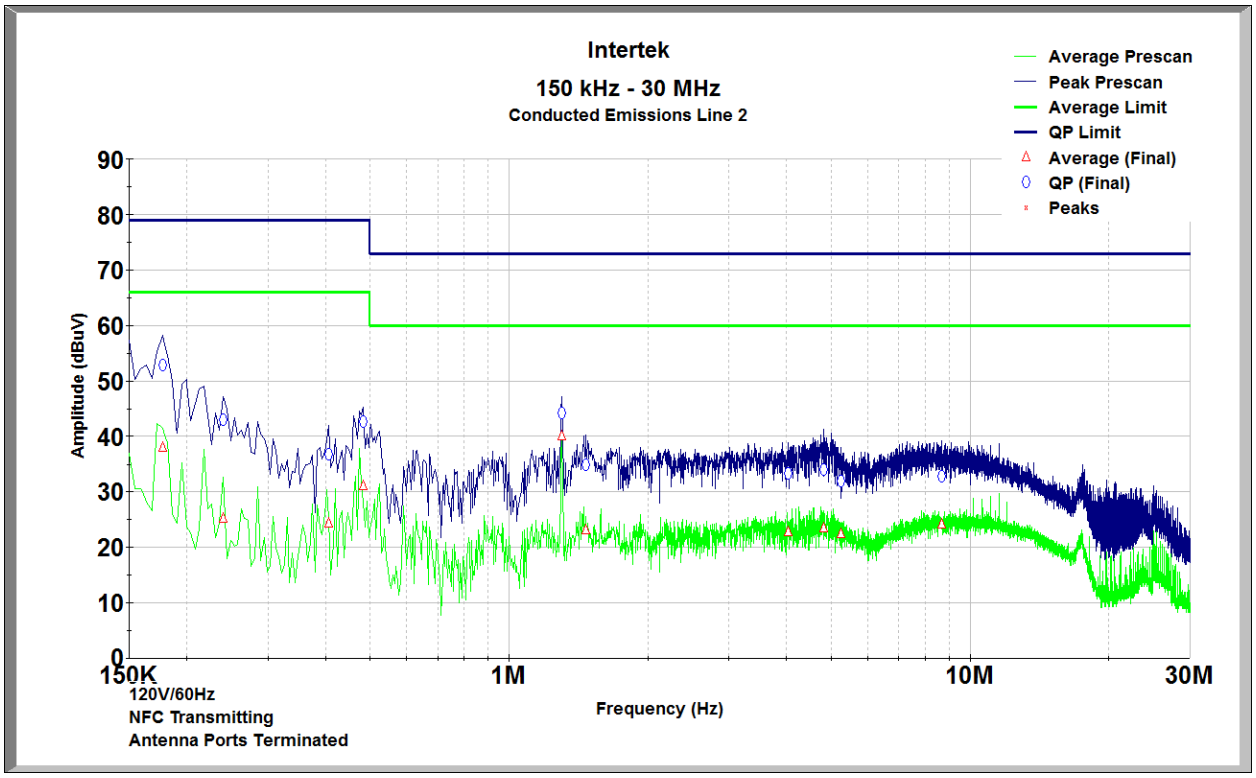
10.8 Plots/Data: Conducted Emissions - NFC Transmitting, Antenna Terminated in Matched Load



Line

Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
0.186	51.624	64.971	13.347	37.006	54.971	17.965
0.249	39.656	63.171	23.515	21.204	53.171	31.967
0.424	41.249	58.157	16.908	28.971	48.157	19.186
0.497	43.300	56.100	12.800	29.193	46.100	16.907
0.609	37.144	56.000	18.953	25.376	46.000	20.721
0.676	36.161	56.000	19.996	23.473	46.000	22.683
1.131	35.995	56.000	20.566	24.134	46.000	22.427
1.302	45.185	56.000	11.527	39.676	46.000	7.037
4.722	35.502	56.000	24.251	25.804	46.000	23.949
7.206	33.867	60.000	22.486	24.650	50.000	21.703

Line



Neutral

Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
0.177	52.927	65.229	12.301	38.008	55.229	17.221
0.240	42.993	63.429	20.435	25.122	53.429	28.306
0.406	36.793	58.671	21.879	24.394	48.671	24.277
0.483	42.738	56.486	13.747	31.065	46.486	15.420
1.302	44.288	56.000	12.425	40.009	46.000	6.704
1.468	34.949	56.000	21.912	23.052	46.000	23.809
4.034	33.363	56.000	25.778	22.845	46.000	26.296
4.816	34.092	56.000	25.745	23.439	46.000	26.398
5.248	31.979	60.000	24.060	22.473	50.000	23.567
8.675	32.823	60.000	23.765	24.173	50.000	22.415

Neutral

Test Personnel:	Brian Lackey	Test Date:	12/28/2018
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class A
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	22.3C
Input Voltage:	120V/60Hz	Relative Humidity:	43.9%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	982.0mbar

Deviations, Additions, or Exclusions: Per FCC Publication Number 174176, the device was tested with its antenna attached, then again with the antenna replaced by a suitable dummy load to determine compliance within the transmitter's fundamental emission band.

11 Antenna Requirement

11.1 Test Limits

FCC Part 15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §§15.211, 15.213, 15.217, 15.219, 15.221, or §15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

RSS-Gen Issue 4 § 8.3:

The applicant for equipment certification, as per RSP-100, must provide a list of all antenna types that may be used with the licence-exempt transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna.

Licence-exempt transmitters that have received equipment certification may operate with different types of antennas. However, it is not permissible to exceed the maximum equivalent isotropically radiated power (e.i.r.p.) limits specified in the applicable standard (RSS) for the licence-exempt apparatus.

Testing shall be performed using the highest gain antenna of each combination of licence-exempt transmitter and antenna type, with the transmitter output power set at the maximum level. When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer.

User manuals for transmitters equipped with detachable antennas shall also contain the following notice in a conspicuous location:

This radio transmitter (identify the device by certification number) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types approved for use with the transmitter, indicating the maximum permissible antenna gain (in dBi).

11.2 Test Results

The device was found to be **compliant**. The device has an internal, permanently affixed antenna.

12 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	1/18/2019	103679095LEX-006	BL	BCT	Original Issue
1	1/23/2019	103679095LEX-006.1	BL	BCT	Updated addresses