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EMC TEST REPORT

Report Number: **102921149LEX-001**
Project Number: **G102921149**

Report Issue Date: **3/8/2017**

Product Name: **GPS-610**

FCC Standards: **Title 47 CFR Part 15 Subpart C**
Industry Canada Standards: **RSS-247 Issue 1 & RSS-GEN Issue 4**

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

Client:
Alcohol Monitoring Systems
1035 Windward Ridge Pkwy Ste 575
Alpharetta, GA 30005-1788

Report prepared by
Brian Lackey, Project Engineer

Report reviewed by
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1 Introduction and Conclusion

The tests indicated in section 2 were performed on the product constructed as described in section 3. 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 complied with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested.

The INTERTEK-Lexington is located at 731 Enterprise Drive, Lexington Kentucky, 40510. The radiated emission test site is a 10-meter semi-anechoic chamber. The chamber meets the characteristics of CISPR 16-1 and ANSI C63.4. 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. The test site is listed with the FCC under registration number 485103. The test site is listed with Industry Canada under site number IC 2042M-1.

2 Test Summary

Page	Test full name	FCC Reference	IC Reference	Result
6	Peak Output Power	§ 15.247(b)(2)	RSS-247 (5.4.1)	Pass
7	Occupied Bandwidth	§ 15.247(a)(1)(i)	RSS-247 (5.1.1)	Pass
11	Channel Separation	§ 15.247(a)(1)	RSS-247 (5.1.2)	Pass
12	Number of Hopping Channels	§ 15.247(a)(1)(iii)	RSS-247 (5.1.3)	Pass
16	Time of Occupancy	§ 15.247(a)(1)(iii)	RSS-247 (5.1.3)	Pass
11	Conducted Spurious Emissions	§ 15.247(d)	RSS-247 (5.5)	Pass
21	Radiated Spurious Emissions (Transmitter)	§ 15.247(d), § 15.209, and § 15.205	RSS-247 (5.5)	Pass
29	Radiated Spurious Emissions (Receiver)	§ 15.109	RSS-Gen (6.1)	Pass
32	AC Powerline Conducted Emissions	§ 15.107, § 15.207	RSS-Gen (7.2.4)	Pass
38	Antenna Requirement per FCC Part 15.203	§ 15.203	RSS-Gen (7.1.2)	Pass

3 Description of Equipment Under Test

Equipment Under Test	
Manufacturer	Alcohol Monitoring Systems
Model Number	GPS-610
Serial Number	Test Sample 1
Receive Date	3/22/2016
Test Start Date	3/22/2016
Test End Date	3/8/2017
Device Received Condition	Good
Test Sample Type	Production
Frequency Band	902MHz-928MHz
Modulation Type	FHSS
Duty Cycle	100%
Transmission Control	Test Commands
Maximum Output Power	-1.48 dBm
Test Channels	6, 59, 120
Antenna Type (15.203)	PCB Antenna
Maximum Antenna Gain [1]	-1.00 dBi
Operating Voltage	5VDC via 120Vac 60Hz Charger

Description of Equipment Under Test
The GPS-610 is a body worn one-piece GPS tracking bracelet that combines superior location accuracy with industry-leading battery life and tamper detection. It integrates the Telit DE910-DUAL module (FCCID: RI7DE910-DUAL) for communication with the cellular network.

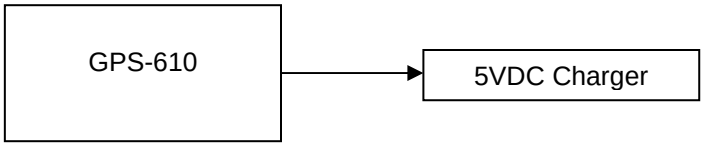
Operating modes of the EUT:

No.	Descriptions of EUT Exercising
1	Transmitting on low, mid, or high channel
2	Frequency hopping mode within 902MHz-928MHz

[1] From antenna datasheet

3.1 System setup including cable interconnection details, support equipment and simplified block diagram

3.2 EUT Block Diagram:



3.3 Cables:

Cables					
Description	Length	Shielding	Ferrites	Connection	
				From	To
Power Cable	1m	No	No	EUT	AC Mains

3.4 Support Equipment:

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
Laptop	HP	EliteBook 8440p	CND046136B

4 Peak Output Power

4.1 Test Limits

§ 15.247(b)(3): For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.

§ 15.247(b)(4): The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

4.2 Test Procedure

ANSI C63.10: 2013 and KDB Publication No. 558074 D01 v03r05: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247). The peak output power was measured using an EMI receiver.

4.3 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	1302.6005.40	Rohde & Schwarz	ESU40	9/26/2016	9/26/2017

4.4 Results:

The peak output power measurements below show that the transmitter is outputting less that the 1W (30dBm) limit.

Mode	Channel Number	Frequency (MHz)	Type	Measured Power (dBm)	Correction Factor (dB)	Conducted Power (dBm)	Limit (dBm)	Margin (dB)
Single TX	6	903.2	Peak	-4.05	2.57	-1.48	30	31.48
Single TX	59	913.8	Peak	-4.18	2.59	-1.59	30	31.59
Single TX	120	926.0	Peak	-4.10	2.61	-1.49	30	31.49

5 Occupied Bandwidth

5.1 Test Limits

§ 15.247(a)(1)(i): For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

5.2 Test Procedure

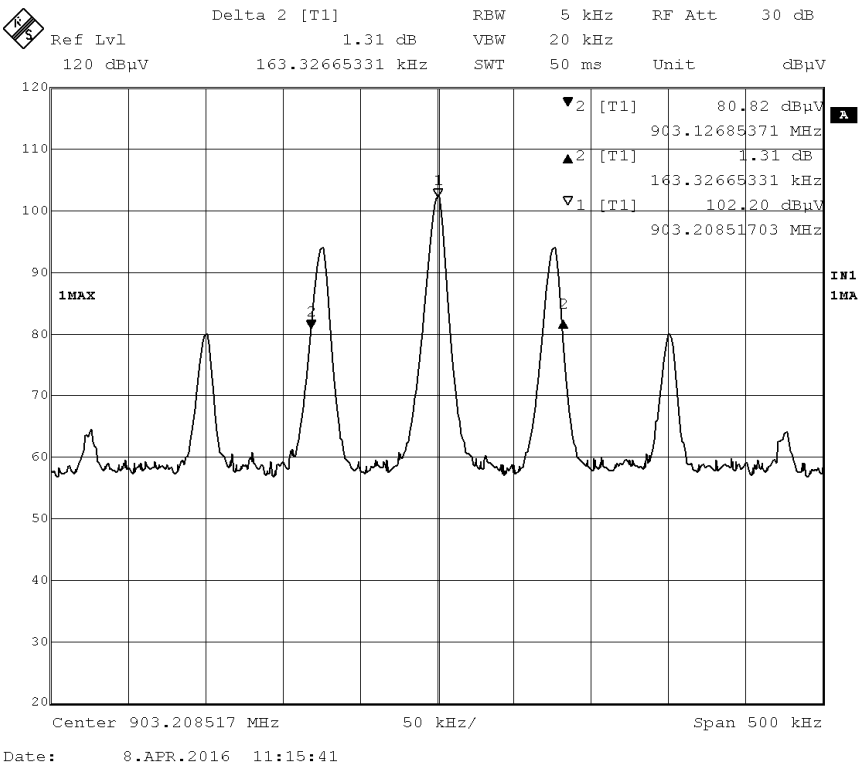
ANSI C63.10: 2013 and KDB Publication No. 558074 D01 v03r05: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

5.3 Test Equipment Used:

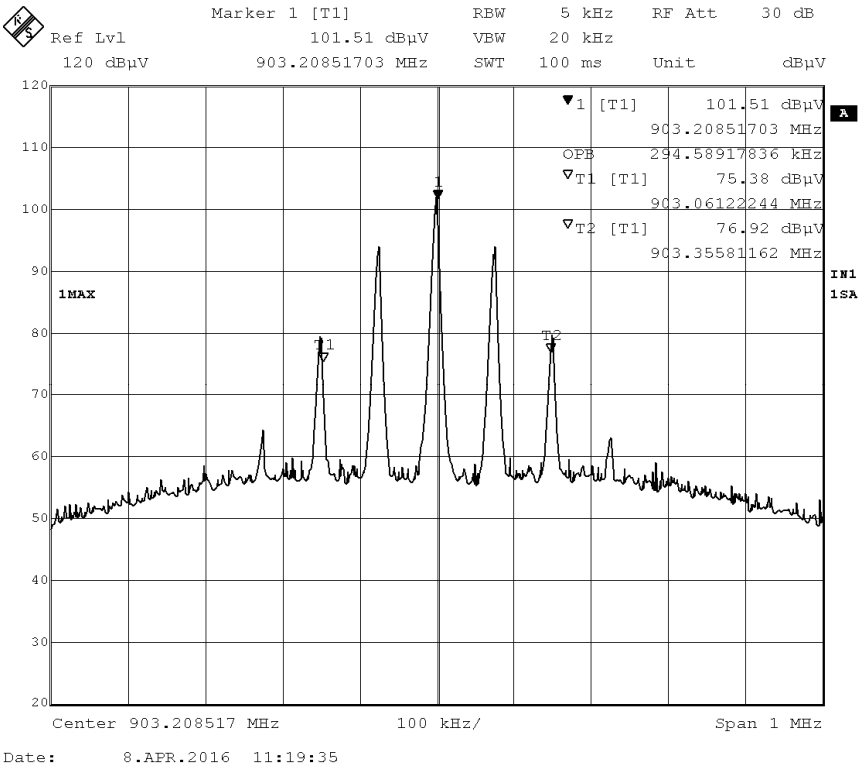
Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2015	9/20/2016

5.4 Results:

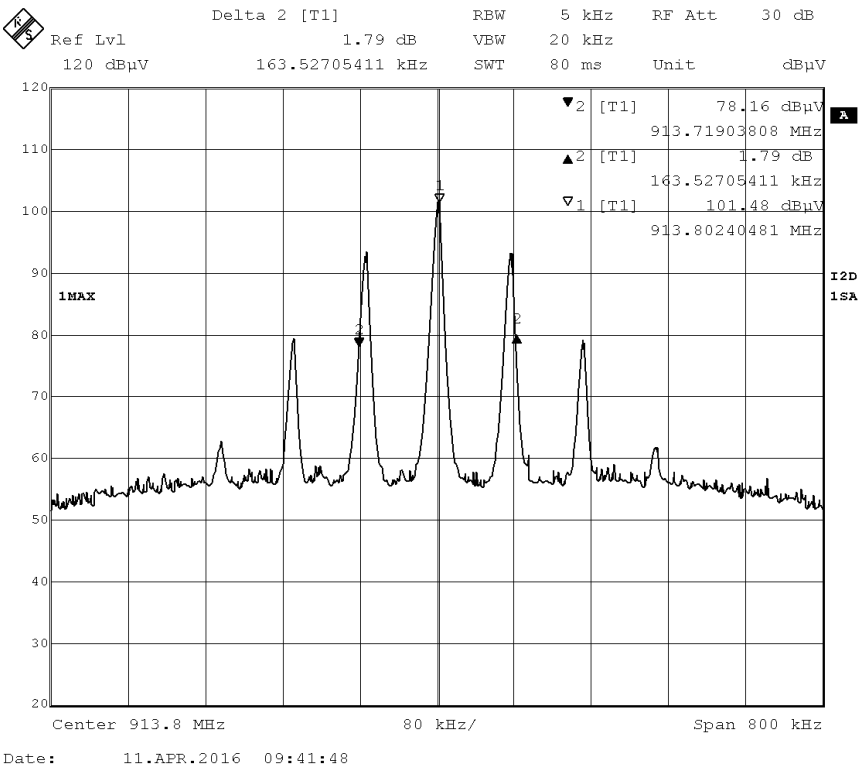
Mode	Channel Number	Frequency (MHz)	20dB Bandwidth	99% Power Bandwidth	Result
Single TX	6	903.2	163.327 kHz	294.589 kHz	Pass
Single TX	59	913.8	163.527 kHz	292.585 kHz	Pass
Single TX	120	926.0	163.527 kHz	290.581 kHz	Pass



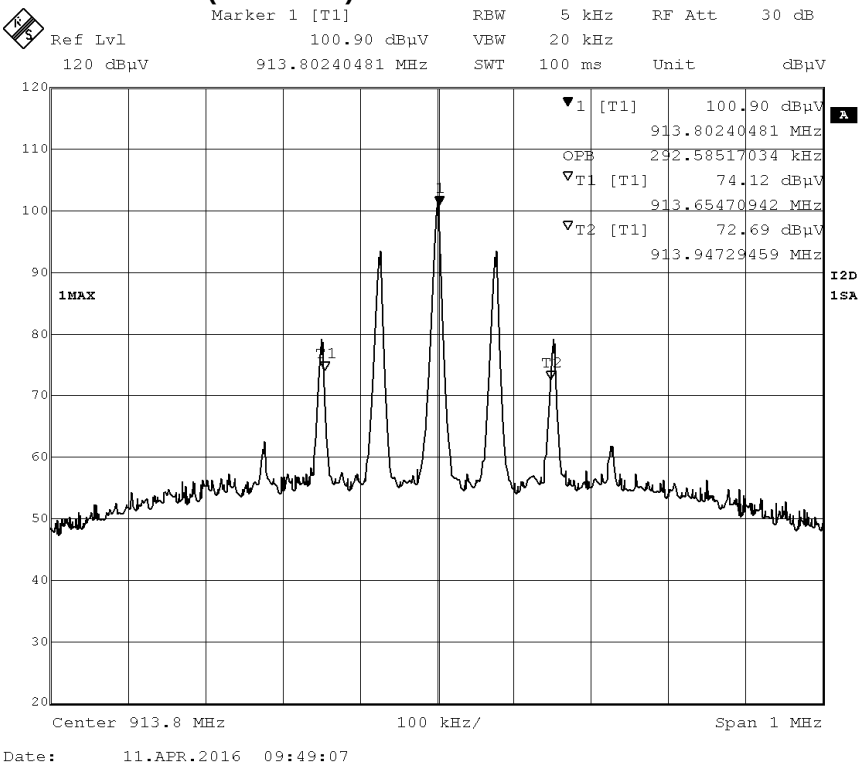
Ch. 6 (903.2 MHz) 20dB Banwidth = 163.327 kHz



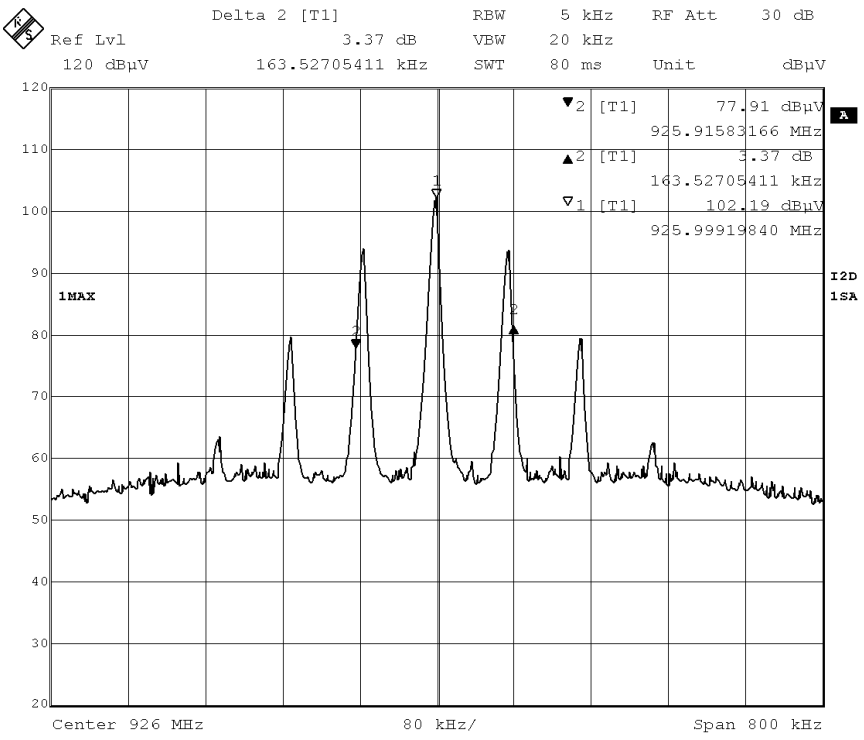
Ch. 6 (903.2 MHz) 99% Power Bandwidth = 294.589 kHz



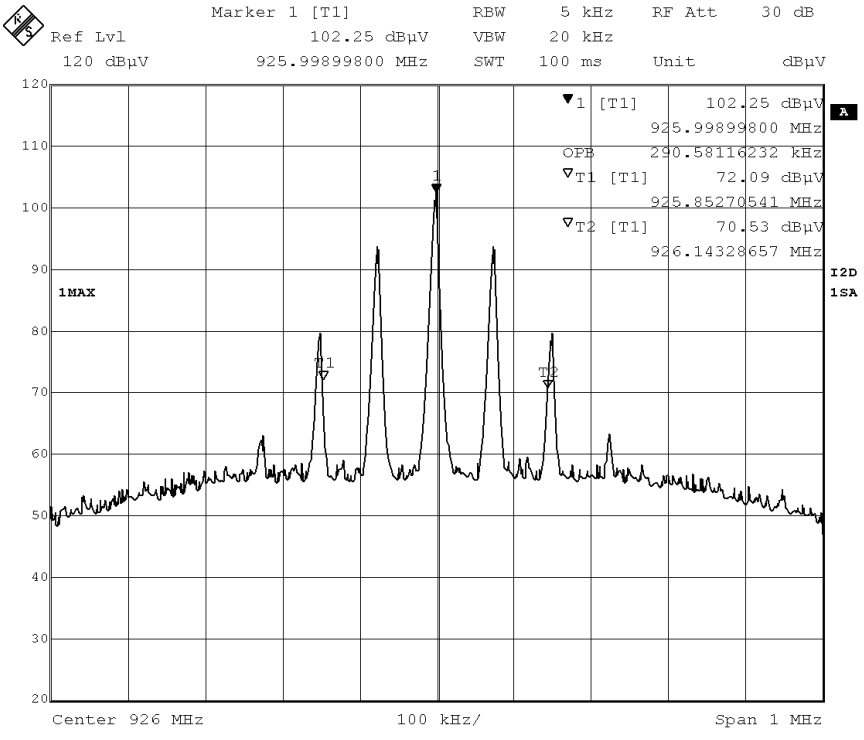
Ch. 59 (913.8 MHz) 20dB Bandwidth = 163.527 kHz



Ch. 59 (913.8 MHz) 99% Power Bandwidth = 292.585 kHz



Ch. 120 (926.0 MHz) 20dB Bandwidth = 163.527 kHz



Ch. 120 (926.0 MHz) 99% Power Bandwidth = 290.581 kHz

6 Channel Separation

6.1 Test Limits

§ 15.247(a): Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

6.2 Test Procedure

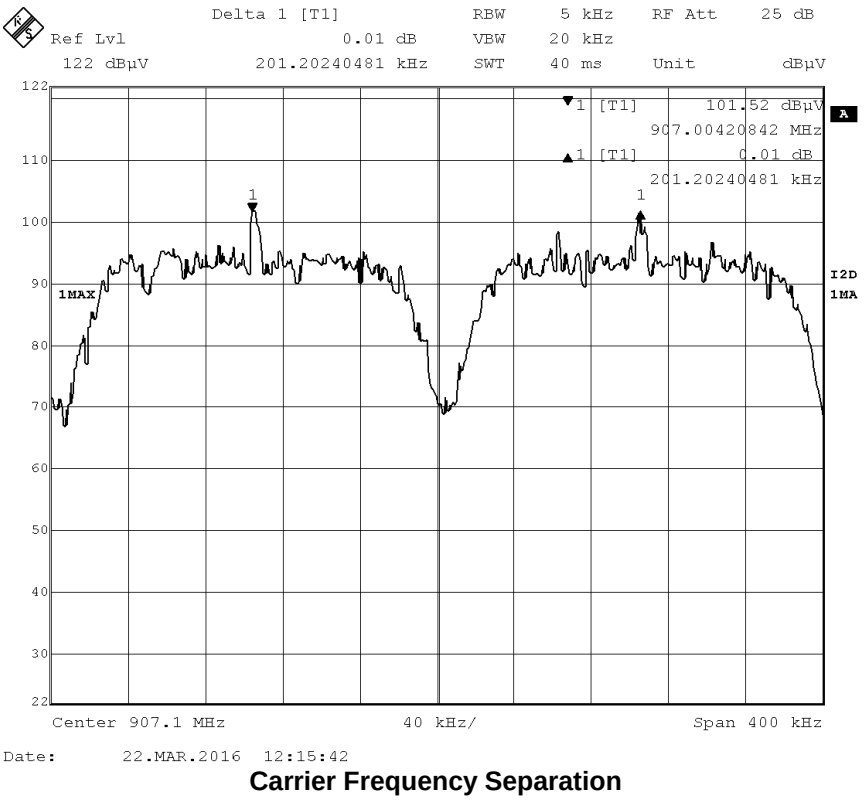
ANSI C63.10: 2013 and FCC Public Notice DA 00-705 Released March 30, 2000: Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

6.3 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2015	9/20/2016

6.4 Results:

The plot below shows that the carrier frequency separation is 201.2kHz.



Carrier Frequency Separation

7 Number of Hopping Channels

7.1 Test Limits

§ 15.247(a): Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(1) (i) For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

7.2 Test Procedure

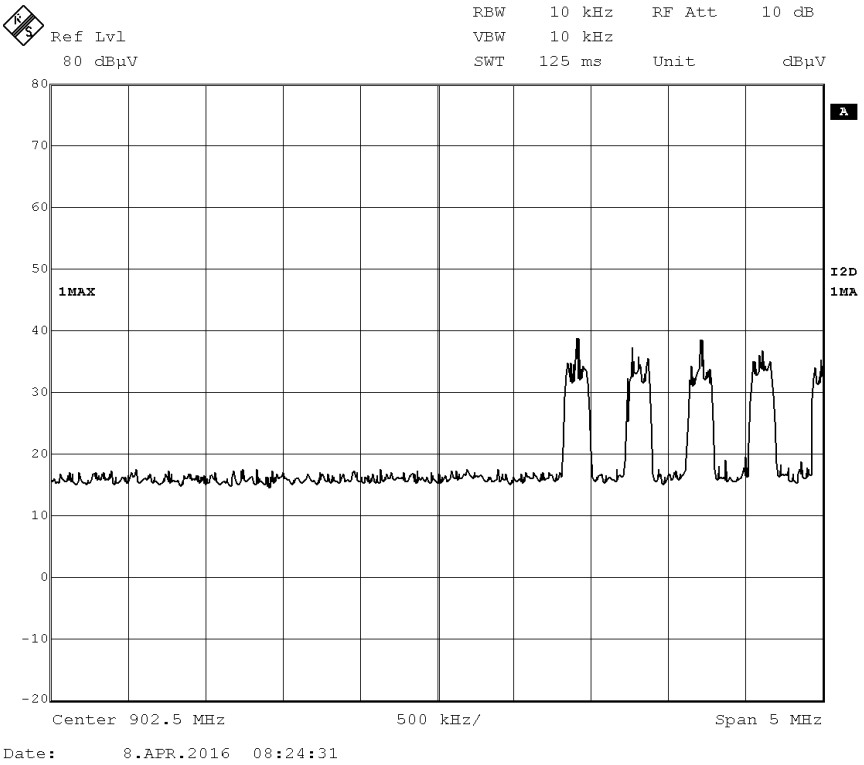
ANSI C63.10: 2013 and FCC Public Notice DA 00-705 Released March 30, 2000: Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

7.3 Test Equipment Used:

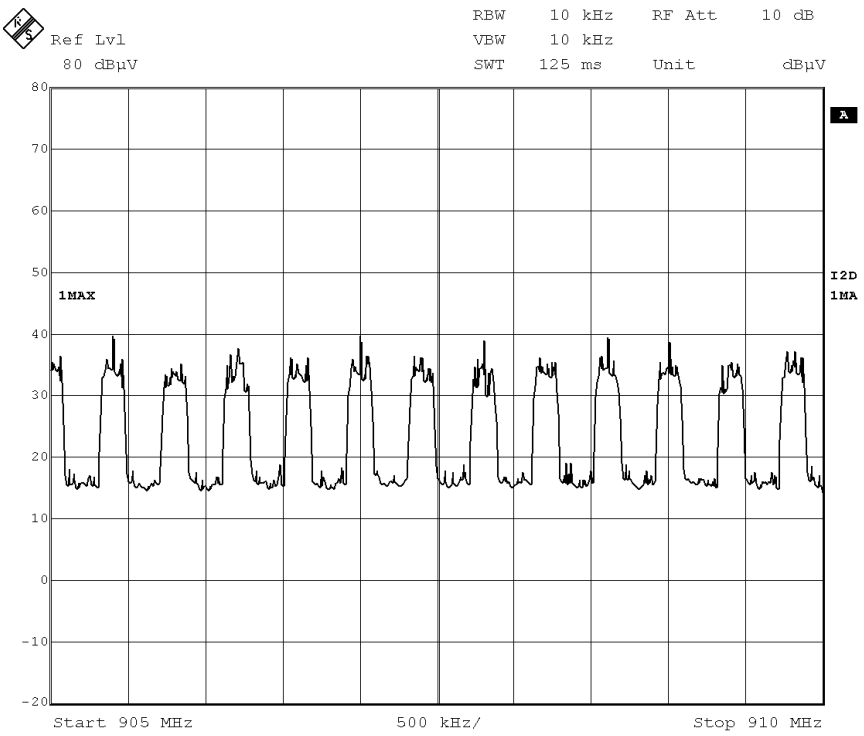
Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2015	9/20/2016

7.4 Results:

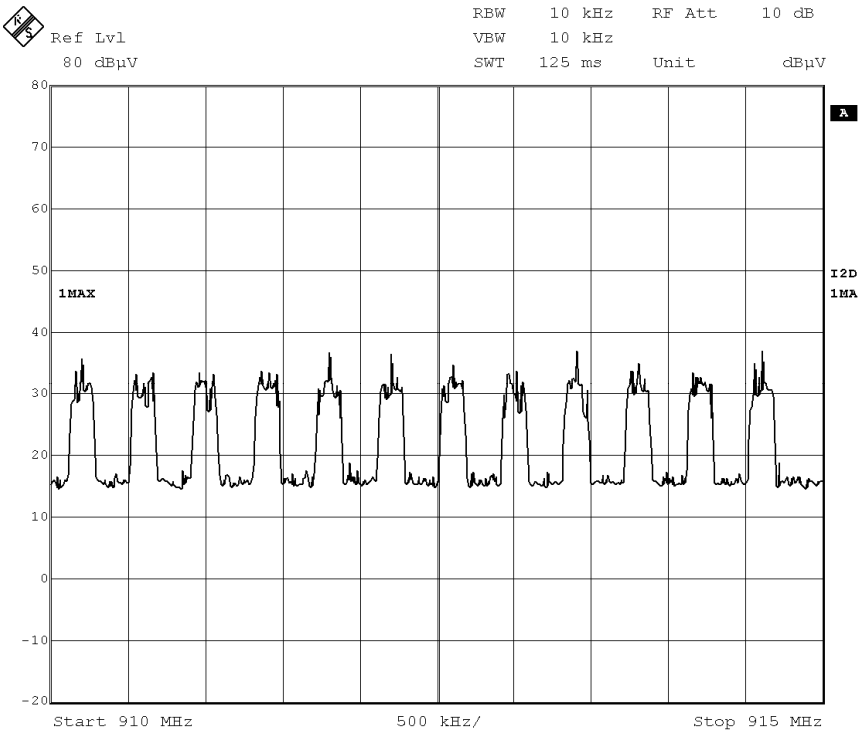
The plots below show that there are 50 hopping frequencies channels being used. The middle of the hopping spectrum was filtered out in order to avoid potential interference with some cordless phones.



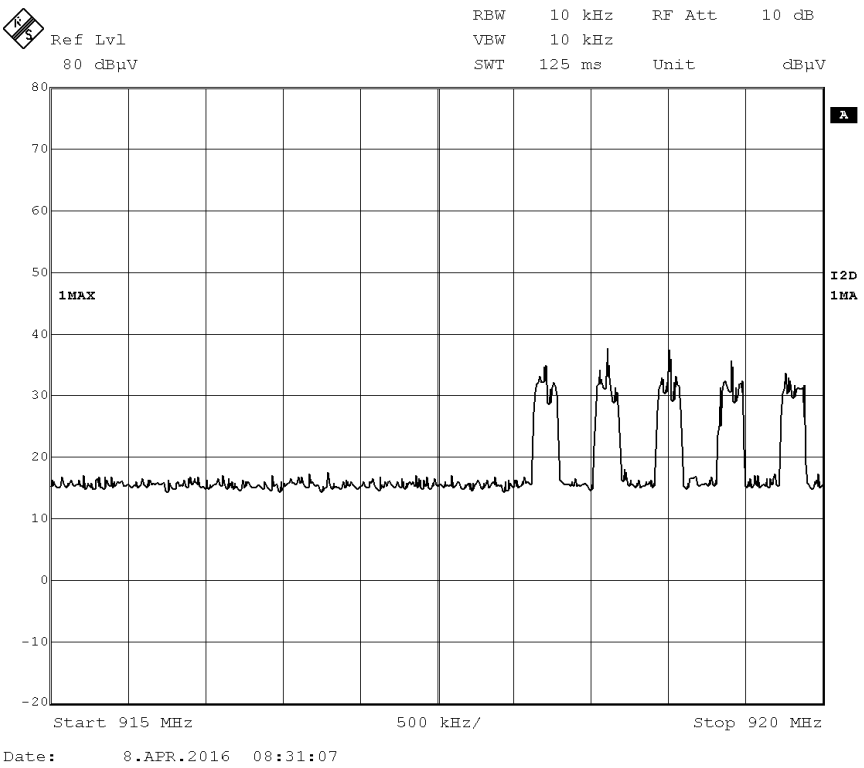
900 MHz – 905 MHz: 4 channels



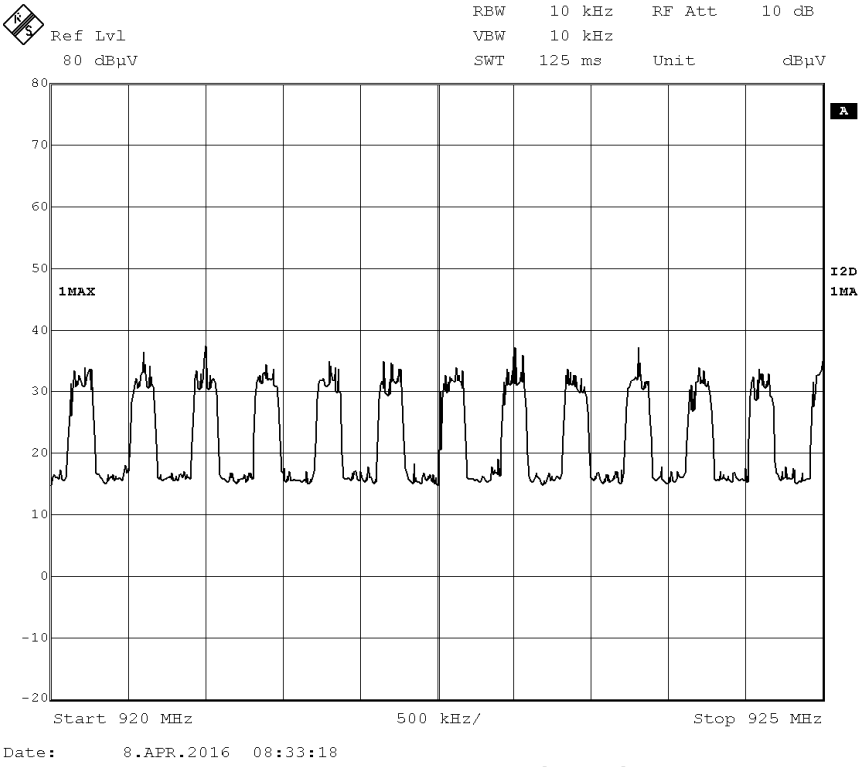
905 MHz – 910 MHz: 13 channels



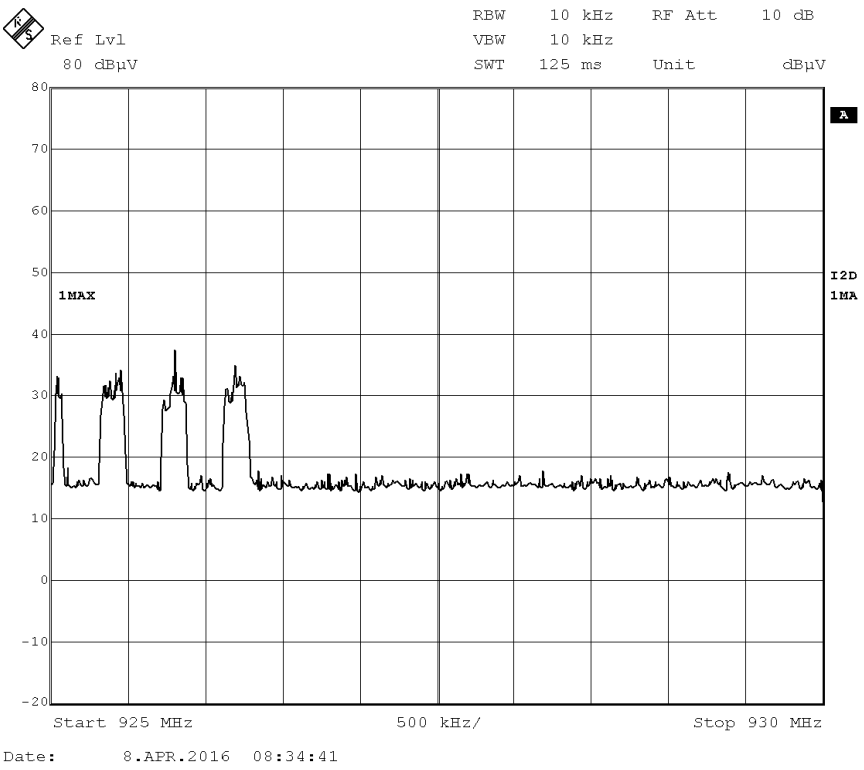
910 MHz – 915 MHz: 12 channels



915 MHz – 920 MHz: 5 channels



920 MHz – 925 MHz: 12 channels



925 MHz – 930 MHz: 4 channels

Total channels = 4 + 13 + 12 + 5 + 12 + 4 = 50 channels

8 Time of Occupancy

8.1 Test Limits

§ 15.247(a): Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(1) (i) For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

8.2 Test Procedure

ANSI C63.10: 2013 and FCC Public Notice DA 00-705 Released March 30, 2000: Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

8.3 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2015	9/20/2016

8.4 Results:

The time of occupancy calculations are shown below. The plots which follow illustrate the on time of the pulses (two lengths) and the number of pulse trains in 20 seconds. The total “on” time is less than the 400mS limit for this product.

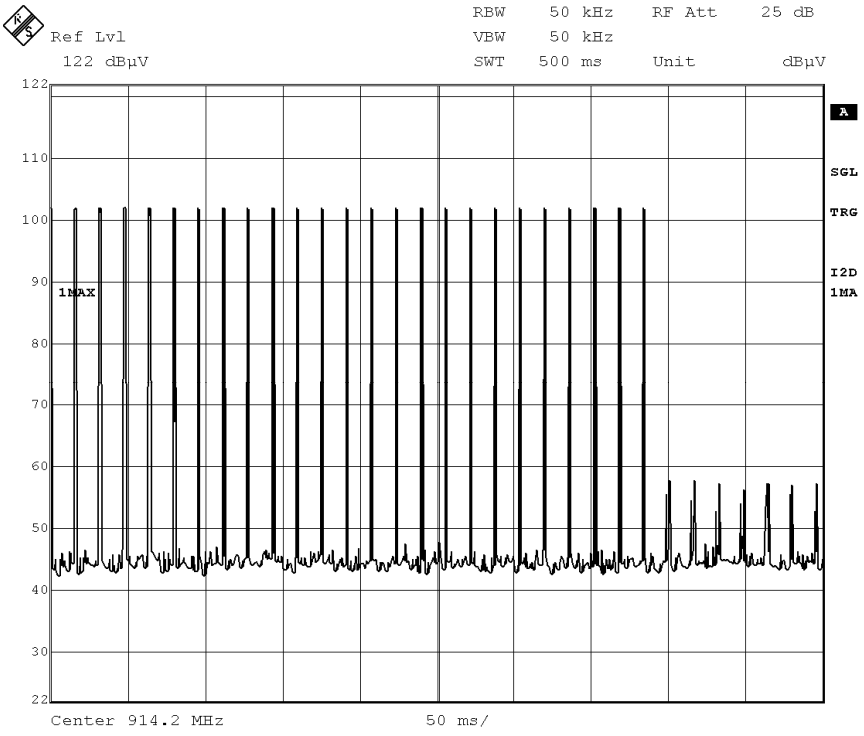
(Beacon On Time) = 25 Beacon Pulses * 1.25mS = 31.25mS

Number of Pulse Trains in 20 Seconds = 2

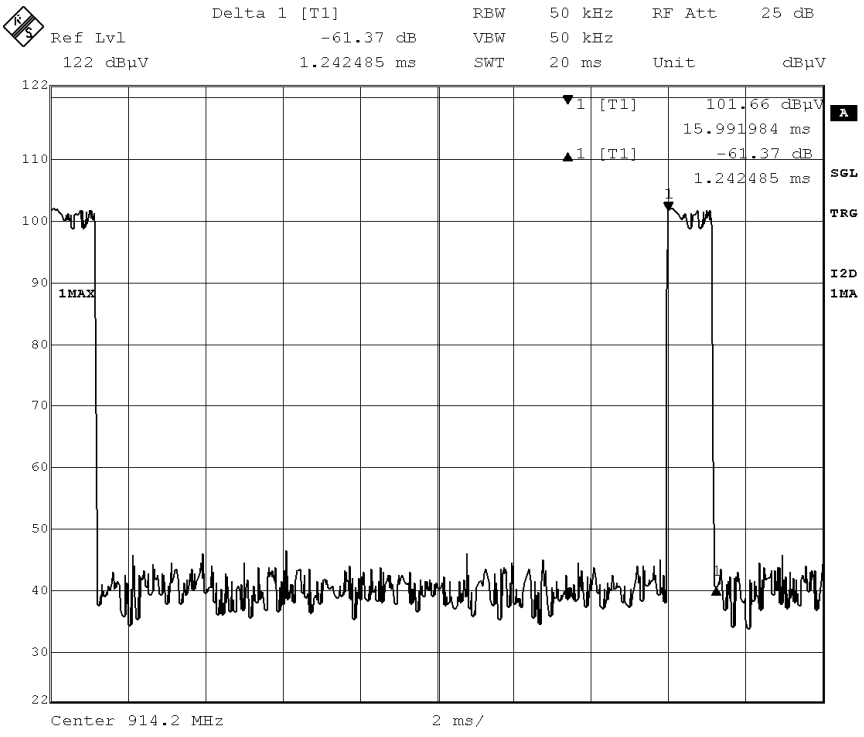
(Total On Time in 20 Seconds) = (31.25mS) * 2 = 62.5mS

Limit = 400mS

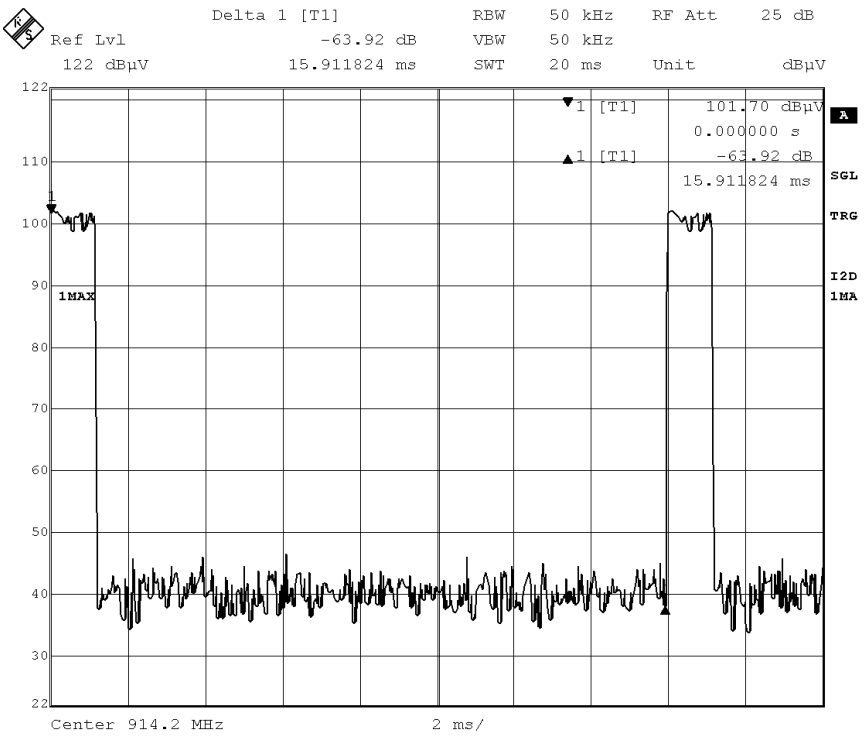
Time of Occupancy Calculation



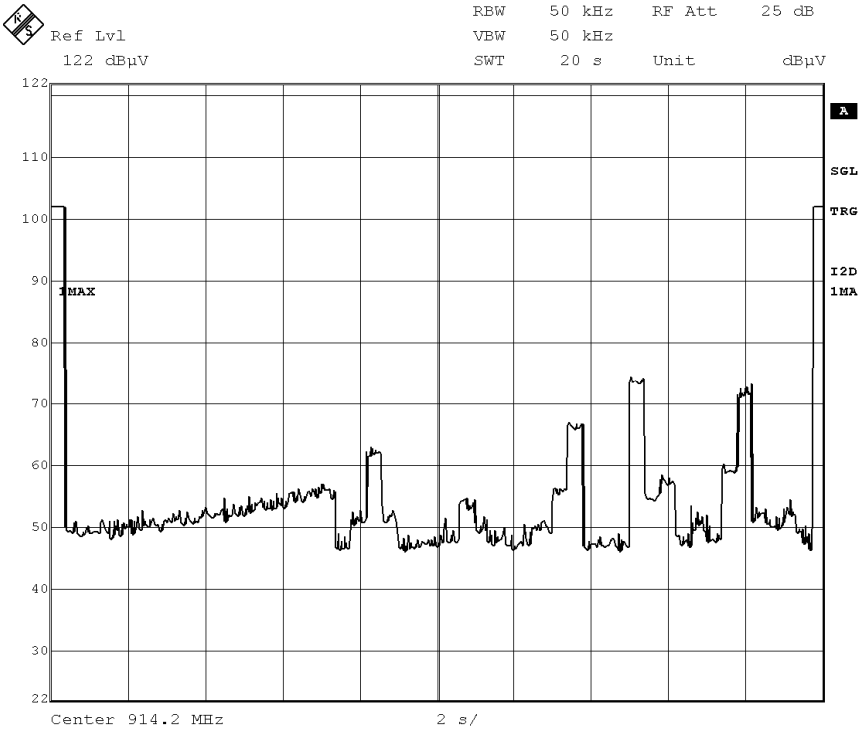
Beacon Pulses in one Train = 25



Beacon On Time = 1.25ms



Beacon Total Time = 15.9ms



Number of Pulse Trains in 20 Seconds = 2

9 Conducted Spurious Emissions

9.1 Test Limits

§ 15.247(d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

9.2 Test Procedure

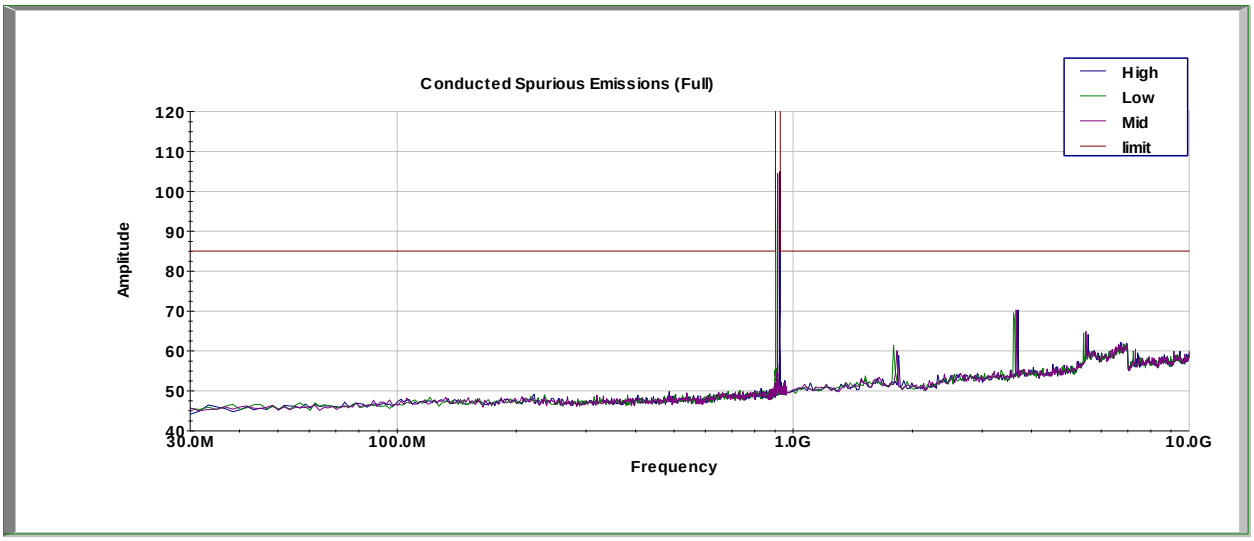
ANSI C63.10: 2013 and KDB Publication No. 558074 D01 v03r05: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

9.3 Test Equipment Used:

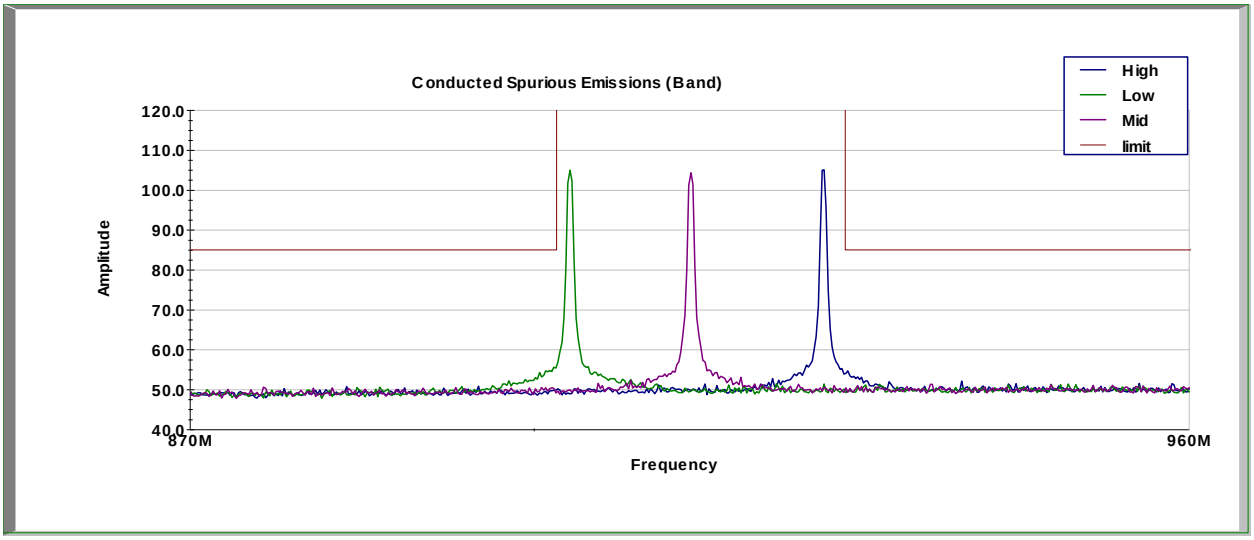
Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2015	9/20/2016

9.4 Results:

The following plots show that there are no conducted spurious emissions exceeding the 20dB down criteria.



Conducted Spurious Emissions – 30 MHz to 10 GHz



Emissions Close to Band Edge

10 Radiated Spurious Emissions (Transmitter)

10.1 Test Limits

§ 15.247(d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Part 15.205(a): Restricted Bands of Operations

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
[1] 0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	[2]
13.36–13.41.			

[1] Until February 1, 1999, this restricted band shall be 0.490–0.510 MHz.
[2] Above 38.6

Part 15.209(a): Field Strength Limits for Restricted Bands of Operation

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2,400 / F (kHz)	300
0.490 - 1.705	24,000 / 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

10.2 Test Procedure

ANSI C63.10: 2013 and KDB Publication No. 558074 D01 v03r05: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

10.3 Example of Field Strength Calculation Method:

The measured field strength was calculated by summing the readings taken from the spectrum analyzer with the appropriate correction factors associated with the antenna losses and cable losses. The calculation formula and sample calculations are listed below:

Formula:
FS = RA + AF + CF

FS = Field Strength in dBμV/m
RA = Receiver Amplitude in dBμV
AF = Antenna Factor in dB
CF = Cable Attenuation Factor in dB (Including preamplifier and filter attenuation)

Example Calculation:

RA = 19.48 dBμV
AF = 18.52 dB
CF = 0.78 dB

FS = 19.48 + 18.52 + 0.78 = 38.78 dBμV/m
Level in μV/m = Common Antilogarithm [(38.78 dBμV/m)/20] = 86.89 μV/m

10.4 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	1302.6005.40	Rohde & Schwarz	ESU40	9/26/2016	9/26/2017
Preamplifier	122005	Rohde&Schwarz	TS-PR18	11/17/2016	11/17/2017
Biconnilog Antenna	00051864	ETS	3142C	3/23/2016	3/23/2017
Horn Antenna	00156319	ETS	3117	3/8/2016	3/8/2017
System Controller	121701-1	Sunol Sciences	SC99V	Verify at Time of Use	Verify at Time of Use
Highpass Filter	25	Wainwright	WHKX12-1028.5-15000-40SS	11/17/2016	11/17/2017
3m Cable Antenna→Preamp	3074			11/17/2016	11/17/2017
3m Cable Preamp→Chamber	2588			11/17/2016	11/17/2017
3m Cable Chamber→Control Room	2593			11/17/2016	11/17/2017
3m Cable Control Room→Receiver	2592			11/17/2016	11/17/2017
10m Cable Antenna→Preamp	3339			11/17/2016	11/17/2017
10m Cable Preamp→Chamber	3172			11/17/2016	11/17/2017
10m Cable Chamber→Control Room	2590			11/17/2016	11/17/2017
10m Cable Control Room→Receiver	2589			11/17/2016	11/17/2017

10.5 Results:

All spurious emissions were attenuated by at least 20dB below the level of the fundamental as required by Part 15.247(d). Additionally, all emissions falling within restricted bands of operation and at the band edges were found to be below the limit specified in Part 15.209(a). The spurious emissions listed in the following tables are the worst case emissions. Emissions were investigated with the test sample positioned in 3 orthogonal axis and the worst case reported.

Channel 6 Spurious Measurements

Final_Result_PK+

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1807.798900	35.43	74.00	38.57	1000.000	161.0	H	0.0	0.5
2709.132900	39.86	74.00	34.14	1000.000	132.0	H	26.0	4.1
3612.498800	43.51	74.00	30.49	1000.000	200.0	H	50.0	5.6
4517.330800	42.90	74.00	31.10	1000.000	135.0	V	28.0	7.7
5419.382400	51.58	74.00	22.42	1000.000	178.0	V	0.0	9.2
6321.783500	45.39	74.00	28.61	1000.000	200.0	V	25.0	9.9
7225.444600	45.44	74.00	28.56	1000.000	130.0	H	50.0	10.4
8128.556100	45.80	74.00	28.20	1000.000	200.0	V	50.0	11.3
9032.684000	47.43	74.00	26.57	1000.000	184.0	V	0.0	12.4

Final_Result_AVG

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1807.798900	23.38	54.00	30.62	1000.000	161.0	H	0.0	0.5
2709.132900	26.49	54.00	27.51	1000.000	132.0	H	26.0	4.1
3612.498800	33.72	54.00	20.28	1000.000	200.0	H	50.0	5.6
4517.330800	29.92	54.00	24.08	1000.000	135.0	V	28.0	7.7
5419.382400	46.28	54.00	7.72	1000.000	178.0	V	0.0	9.2
6321.783500	32.25	54.00	21.75	1000.000	200.0	V	25.0	9.9
7225.444600	33.98	54.00	20.02	1000.000	130.0	H	50.0	10.4
8128.556100	33.37	54.00	20.63	1000.000	200.0	V	50.0	11.3
9032.684000	35.09	54.00	18.91	1000.000	184.0	V	0.0	12.4

Test Personnel:	Bryan Taylor	Test Date:	3/6/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart C		
Input Voltage:	5VDC (Charging)	Ambient Temperature:	21.0 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	21.0 %

Channel 59 Spurious Measurements

Final_Result_PK+

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1827.229800	35.94	74.00	38.06	1000.000	134.0	H	24.0	0.6
2742.451800	39.69	74.00	34.31	1000.000	134.0	H	50.0	4.2
3654.894900	42.86	74.00	31.14	1000.000	200.0	H	50.0	5.7
4570.349400	42.89	74.00	31.11	1000.000	180.0	V	50.0	7.7
5483.025900	53.59	74.00	20.41	1000.000	179.0	V	11.0	9.4
6396.286800	44.70	74.00	29.30	1000.000	170.0	V	26.0	10.3
7310.209800	47.23	74.00	26.77	1000.000	133.0	H	39.0	10.5
8223.750900	46.34	74.00	27.66	1000.000	200.0	V	50.0	11.4
9138.760500	47.52	74.00	26.48	1000.000	154.0	V	50.0	12.7

Final_Result_AVG

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1827.229800	23.81	54.00	30.19	1000.000	134.0	H	24.0	0.6
2742.451800	26.52	54.00	27.48	1000.000	134.0	H	50.0	4.2
3654.894900	32.81	54.00	21.19	1000.000	200.0	H	50.0	5.7
4570.349400	29.60	54.00	24.40	1000.000	180.0	V	50.0	7.7
5483.025900	48.35	54.00	5.65	1000.000	179.0	V	11.0	9.4
6396.286800	32.49	54.00	21.51	1000.000	170.0	V	26.0	10.3
7310.209800	38.17	54.00	15.83	1000.000	133.0	H	39.0	10.5
8223.750900	33.21	54.00	20.79	1000.000	200.0	V	50.0	11.4
9138.760500	34.92	54.00	19.08	1000.000	154.0	V	50.0	12.7

Test Personnel:	Bryan Taylor	Test Date:	3/6/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart C		
Input Voltage:	5VDC (Charging)	Ambient Temperature:	21.0 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	21.0 %

Channel 120 Spurious Measurements

Final_Result_PK+

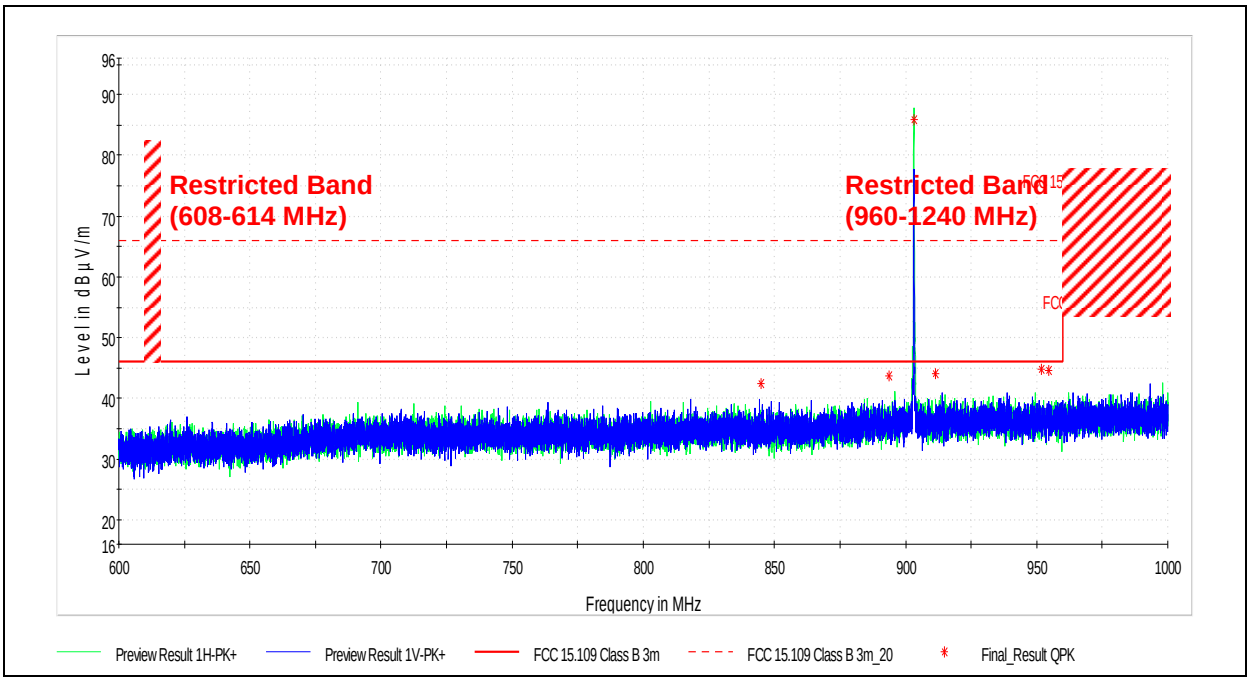
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1851.813400	37.83	74.00	36.17	1000.000	146.0	H	24.0	0.8
2778.347400	38.86	74.00	35.14	1000.000	173.0	V	37.0	4.2
3703.911500	43.79	74.00	30.21	1000.000	176.0	H	50.0	5.7
4631.147200	43.29	74.00	30.71	1000.000	141.0	V	33.0	7.7
5555.674200	54.75	74.00	19.25	1000.000	173.0	V	50.0	9.5
6482.596400	44.11	74.00	29.89	1000.000	160.0	V	50.0	10.5
7407.815200	46.24	74.00	27.76	1000.000	129.0	H	38.0	10.8
8333.632500	45.89	74.00	28.11	1000.000	158.0	V	0.0	11.4
9259.499600	48.90	74.00	25.10	1000.000	200.0	H	50.0	12.8

Final_Result_AVG

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1851.813400	27.05	54.00	26.95	1000.000	146.0	H	24.0	0.8
2778.347400	26.52	54.00	27.48	1000.000	173.0	V	37.0	4.2
3703.911500	35.82	54.00	18.18	1000.000	176.0	H	50.0	5.7
4631.147200	29.52	54.00	24.48	1000.000	141.0	V	33.0	7.7
5555.674200	49.98	54.00	4.02	1000.000	173.0	V	50.0	9.5
6482.596400	31.95	54.00	22.05	1000.000	160.0	V	50.0	10.5
7407.815200	35.82	54.00	18.18	1000.000	129.0	H	38.0	10.8
8333.632500	32.81	54.00	21.19	1000.000	158.0	V	0.0	11.4
9259.499600	38.30	54.00	15.70	1000.000	200.0	H	50.0	12.8

Test Personnel:	Bryan Taylor	Test Date:	3/6/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart C		
Input Voltage:	5VDC (Charging)	Ambient Temperature:	21.0 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	21.0 %

10.5.1 Low Channel Band Edge Emissions

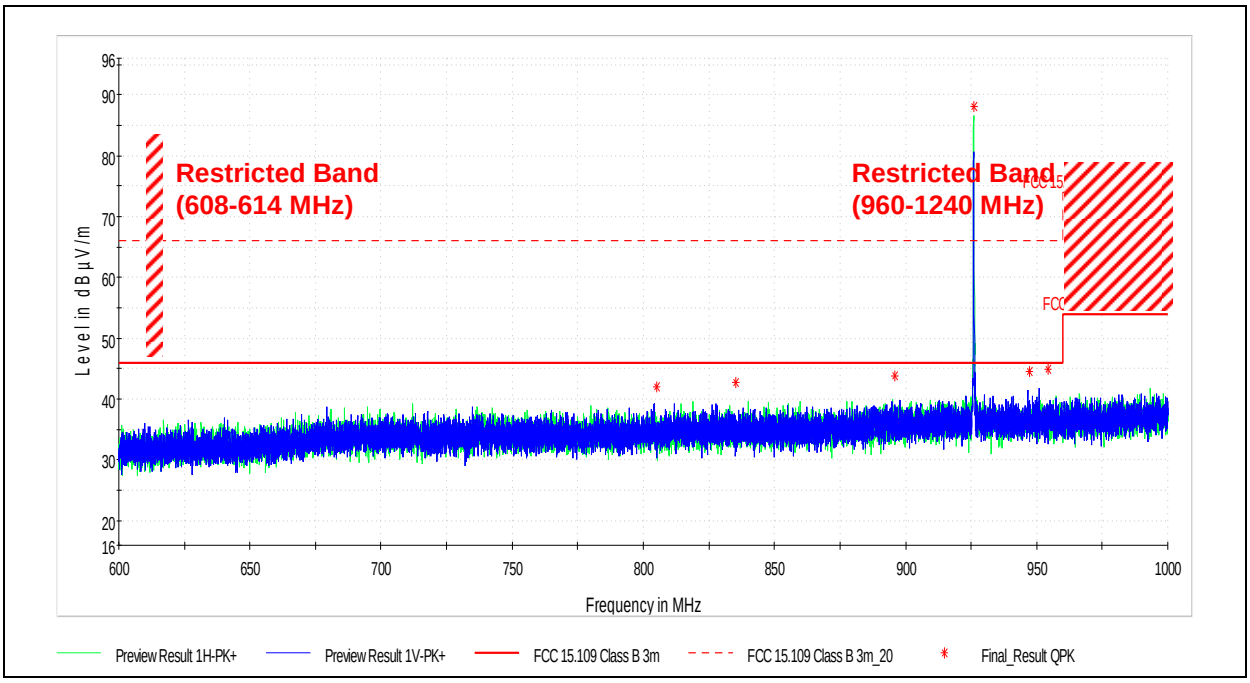


Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
844.780000	42.41	46.02	3.61	120.000	399.9	V	0.0	34.3
893.580000	43.74	46.02	2.28	120.000	104.8	H	63.0	35.4
911.300000	44.13	46.02	1.89	120.000	118.1	V	290.0	35.7
951.860000	44.80	46.02	1.22	120.000	335.2	H	120.0	35.9
954.680000	44.67	46.02	1.35	120.000	343.4	H	54.0	35.9

Test Personnel:	Bryan Taylor	Test Date:	3/6/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart C		
Input Voltage:	5VDC (Charging)	Ambient Temperature:	21.0 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	21.0 %

10.5.2 High Channel Band Edge Emissions



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
805.160000	42.00	46.02	4.02	120.000	111.9	V	249.0	34.0
835.260000	42.73	46.02	3.29	120.000	109.1	H	50.0	34.6
896.020000	43.89	46.02	2.13	120.000	114.1	H	163.0	35.5
947.140000	44.53	46.02	1.49	120.000	110.3	V	13.0	35.9
954.340000	44.85	46.02	1.17	120.000	112.8	H	224.0	35.9

Test Personnel:	Bryan Taylor	Test Date:	3/6/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart C		
Input Voltage:	5VDC (Charging)	Ambient Temperature:	21.0 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	21.0 %

11 Radiated Spurious Emissions (Receiver)

11.1 Test Limits

§ 15.109: Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency of emission (MHz)	Field strength (microvolts/meter)	Field strength (dBuV/m)
30–88	100	40
88–216	150	43.5
216–960	200	46
Above 960	500	54

These limits are identical to those in RSS-GEN

11.2 Test Procedure

ANSI C63.4: 2014

11.3 Example of Field Strength Calculation Method:

The measured field strength was calculated by summing the readings taken from the spectrum analyzer with the appropriate correction factors associated with the antenna losses and cable losses. The calculation formula and sample calculations are listed below:

Formula:
FS = RA + AF + CF

FS = Field Strength in dBµV/m
RA = Receiver Amplitude in dBµV
AF = Antenna Factor in dB
CF = Cable Attenuation Factor in dB (Including preamplifier and filter attenuation)

Example Calculation:

RA = 19.48 dBµV
AF = 18.52 dB
CF = 0.78 dB

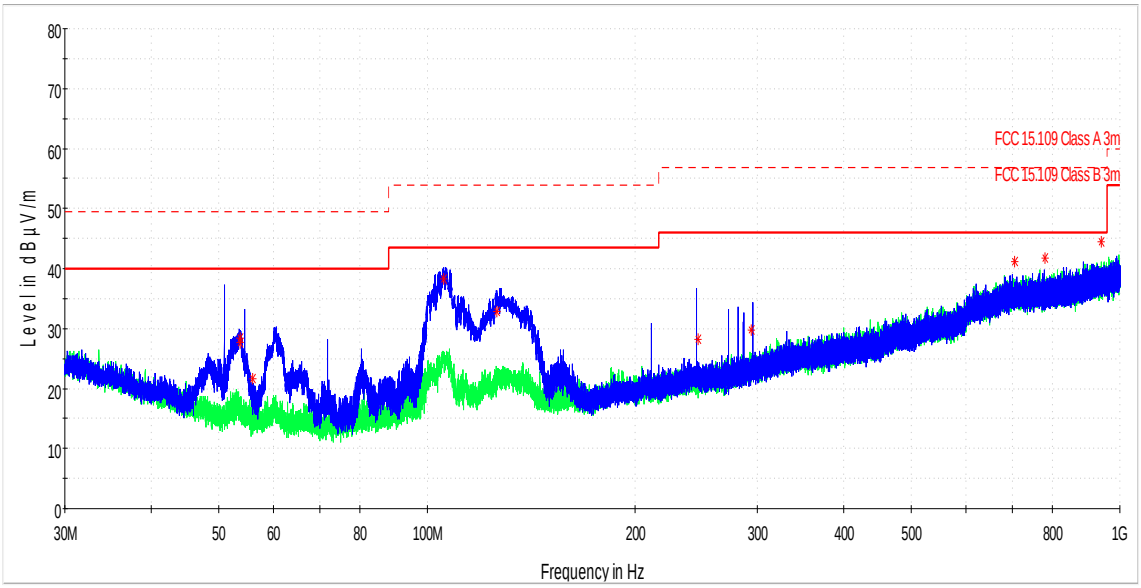
FS = 19.48 + 18.52 + 0.78 = 38.78 dBµV/m
Level in µV/m = Common Antilogarithm [(38.78 dBµV/m)/20] = 86.89 µV/m

11.4 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	1302.6005.40	Rohde & Schwarz	ESU40	9/26/2016	9/26/2017
Preamplifier	122005	Rohde&Schwarz	TS-PR18	11/17/2016	11/17/2017
Biconnilog Antenna	00051864	ETS	3142C	3/23/2016	3/23/2017
Horn Antenna	00156319	ETS	3117	3/8/2016	3/8/2017
System Controller	121701-1	Sunol Sciences	SC99V	Verify at Time of Use	Verify at Time of Use
3m Cable Antenna→Preamp	3074			11/17/2016	11/17/2017
3m Cable Preamp→Chamber	2588			11/17/2016	11/17/2017
3m Cable Chamber→Control Room	2593			11/17/2016	11/17/2017
3m Cable Control Room→Receiver	2592			11/17/2016	11/17/2017
10m Cable Antenna→Preamp	3339			11/17/2016	11/17/2017
10m Cable Preamp→Chamber	3172			11/17/2016	11/17/2017
10m Cable Chamber→Control Room	2590			11/17/2016	11/17/2017
10m Cable Control Room→Receiver	2589			11/17/2016	11/17/2017

11.5 Results:

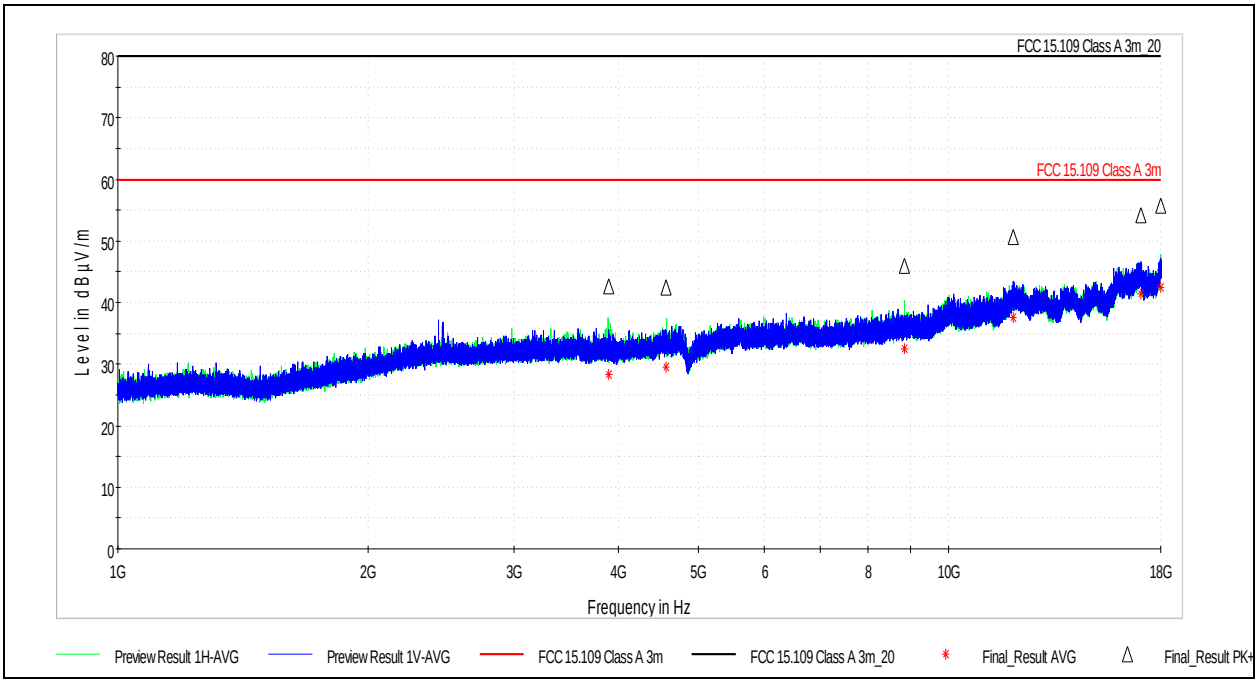
All spurious emissions with the test sample in receive mode were below the limits specified in Part 15.109 for a class B digital device and RSS-GEN Section 6.1.



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
53.692000	28.31	40.00	11.69	120.000	105.3	V	6.0	15.0
53.695000	27.54	40.00	12.46	120.000	99.7	V	324.0	15.0
56.061000	21.58	40.00	18.42	120.000	325.0	V	340.0	14.7
105.580000	38.33	43.52	5.19	120.000	103.7	V	285.0	16.6
126.060000	32.85	43.52	10.67	120.000	103.9	V	303.0	16.5
246.300000	28.12	46.02	17.90	120.000	153.8	V	18.0	21.3
294.200000	29.79	46.02	16.23	120.000	343.0	V	101.0	23.1
704.440000	41.19	46.02	4.83	120.000	369.9	V	146.0	33.6
780.350000	41.72	46.02	4.30	120.000	388.4	V	82.0	33.8
940.540000	44.39	46.02	1.63	120.000	386.5	H	173.0	35.7

Test Personnel:	Carmen Davis	Test Date:	12/14/2016
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart B		
Input Voltage:	Charging / Radios Idle	Ambient Temperature:	21.0 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	21.0 %



Final_Result_PK+

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
3895.259100	42.59	80.00	37.41	1000.000	300.0	H	263.0	6.1
4570.646000	42.40	80.00	37.60	1000.000	276.0	H	321.0	7.7
8854.893300	45.91	80.00	34.09	1000.000	278.0	H	46.0	12.1
11954.345800	50.64	80.00	29.36	1000.000	170.0	V	130.0	17.5
17053.378200	54.19	80.00	25.81	1000.000	130.0	V	321.0	21.4
17998.391969	55.69	80.00	24.31	1000.000	169.0	H	-10.0	23.0

Final_Result_AVG

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
3895.259100	28.38	60.00	31.62	1000.000	300.0	H	263.0	6.1
4570.646000	29.59	60.00	30.41	1000.000	276.0	H	321.0	7.7
8854.893300	32.53	60.00	27.47	1000.000	278.0	H	46.0	12.1
11954.345800	37.60	60.00	22.40	1000.000	170.0	V	130.0	17.5
17053.378200	41.45	60.00	18.55	1000.000	130.0	V	321.0	21.4
17998.391969	42.53	60.00	17.47	1000.000	169.0	H	-10.0	23.0

Test Personnel:	Carmen Davis	Test Date:	12/14/2016
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart B		
Input Voltage:	Charging / Radios Idle	Ambient Temperature:	21.0 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	21.0 %

12 AC Powerline Conducted Emissions

12.1 Test Limits

§ 15.107(e): Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases with the logarithm of the frequency.

12.2 Test Procedure

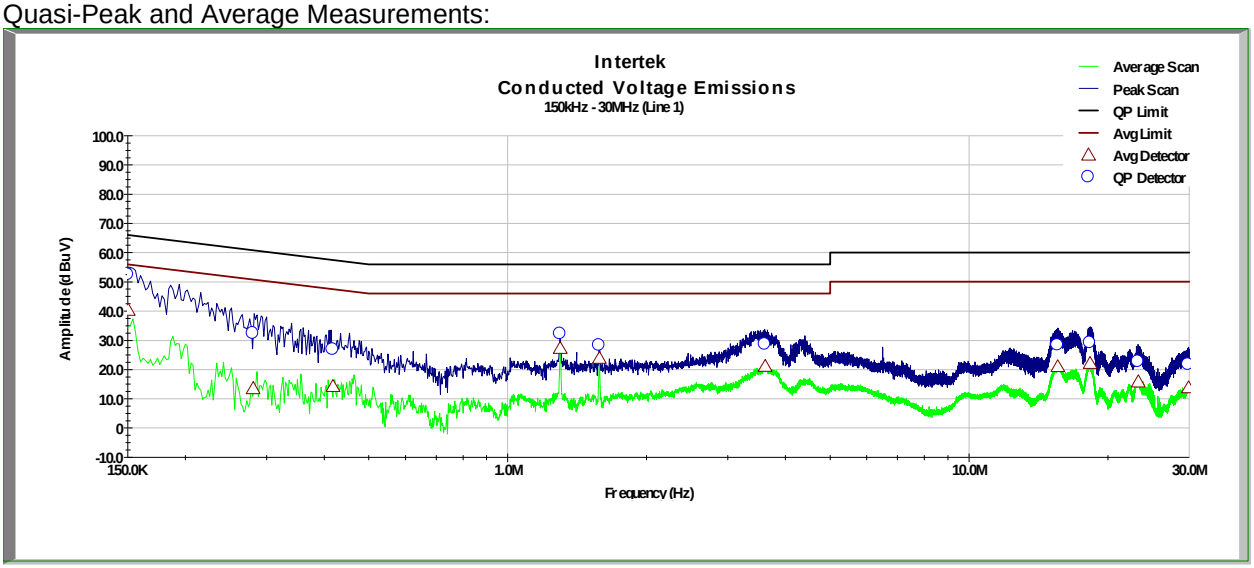
ANSI C63.4: 2014

12.3 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2015	9/20/2016
LISN	2509	Fischer Custom Communication	FCC-LISN-50-50-2M	3/17/2016	3/17/2017

12.4 Results (Line 1, Transmitting):

Quasi-Peak and Average Measurements:

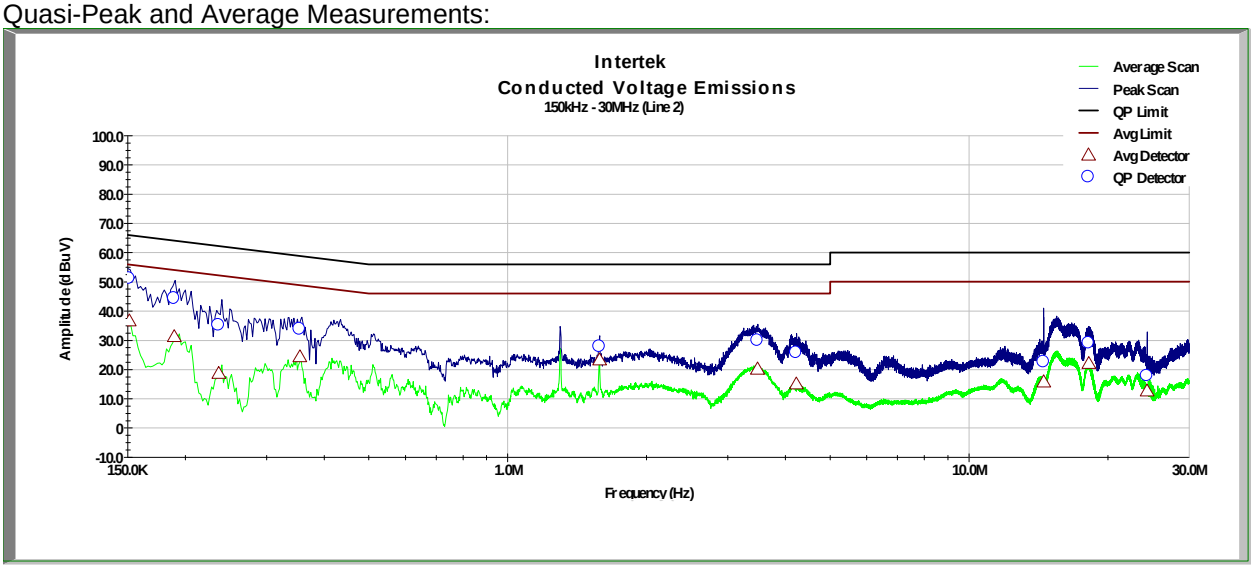


Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
150.300 KHz	52.367	65.991	13.625	40.304	55.991	15.687
280.600 KHz	32.294	62.269	29.975	13.474	52.269	38.795
418.100 KHz	26.783	58.340	31.557	14.192	48.340	34.148
1.300 MHz	32.137	56.000	23.863	27.250	46.000	18.750
1.580 MHz	28.197	56.000	27.803	23.842	46.000	22.158
3.615 MHz	28.540	56.000	27.460	21.067	46.000	24.933
15.582 MHz	28.296	60.000	31.704	20.957	50.000	29.043
18.301 MHz	29.054	60.000	30.946	22.087	50.000	27.913
23.268 MHz	22.590	60.000	37.410	15.780	50.000	34.220
29.904 MHz	21.659	60.000	38.341	13.786	50.000	36.214

Test Personnel:	Brian Lackey	Test Date:	3/23/2016
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart B		
Input Voltage:	5VDC (Charging)	Ambient Temperature:	21.0 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	**12.0 %**

12.1 Results (Line 2, Transmitting)

Quasi-Peak and Average Measurements:

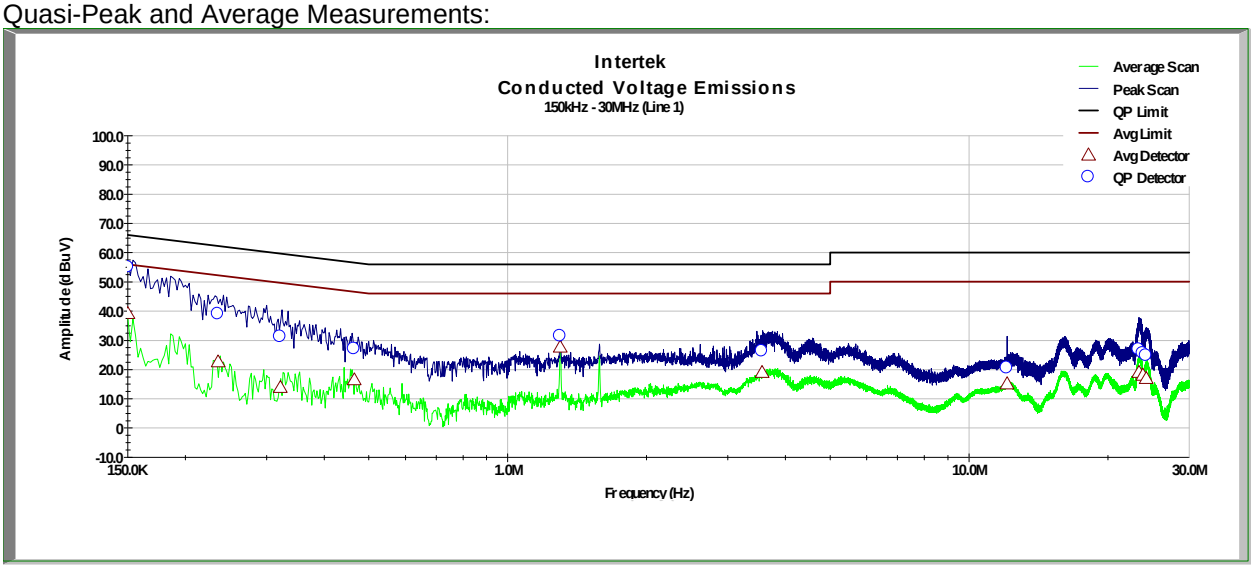


Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
151.300 KHz	51.134	65.963	14.829	36.653	55.963	19.310
189.300 KHz	44.261	64.877	20.617	31.307	54.877	23.570
236.400 KHz	35.070	63.531	28.462	18.644	53.531	34.888
354.300 KHz	33.738	60.163	26.425	24.379	50.163	25.784
1.582 MHz	27.764	56.000	28.236	23.278	46.000	22.722
3.480 MHz	29.837	56.000	26.163	20.165	46.000	25.835
4.225 MHz	25.638	56.000	30.362	15.071	46.000	30.929
14.521 MHz	22.475	60.000	37.525	15.799	50.000	34.201
18.186 MHz	29.013	60.000	30.987	22.075	50.000	27.925
24.325 MHz	17.744	60.000	42.256	12.677	50.000	37.323

Test Personnel:	Brian Lackey	Test Date:	3/23/2016
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart B		
Input Voltage:	5VDC (Charging)	Ambient Temperature:	21.0 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	**12.2** **%**

12.3 Results (Line 1, Idle)

Quasi-Peak and Average Measurements:

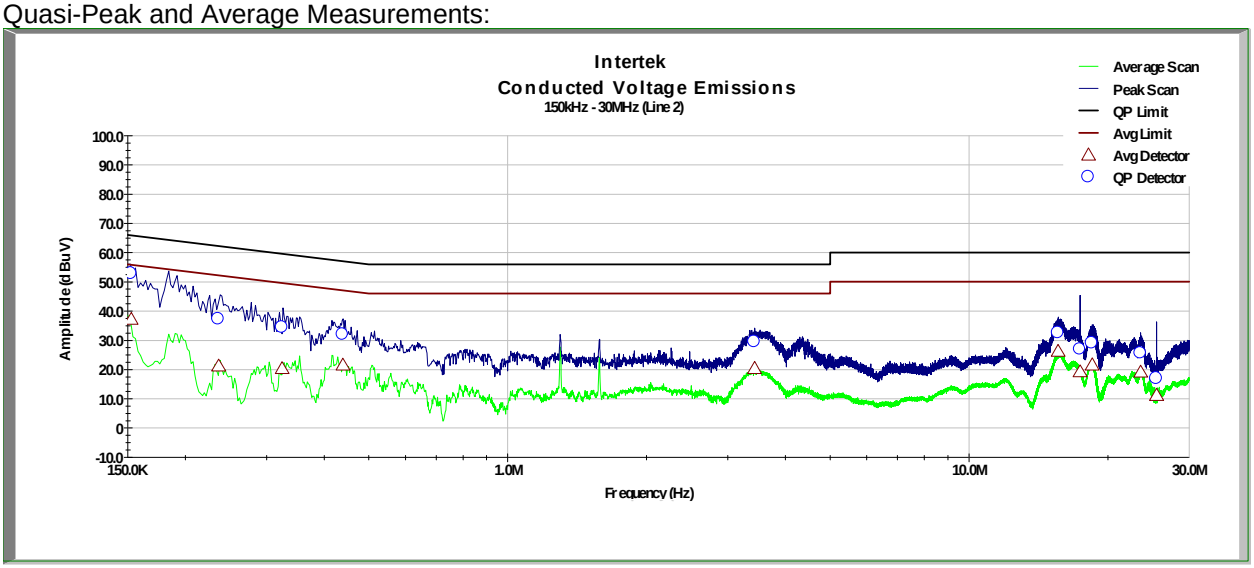


Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
150.200 KHz	54.946	65.994	11.048	39.141	55.994	16.853
235.600 KHz	38.935	63.554	24.619	22.634	53.554	30.921
321.500 KHz	31.177	61.100	29.923	13.896	51.100	37.204
464.800 KHz	26.995	57.006	30.010	16.477	47.006	30.529
1.300 MHz	31.324	56.000	24.676	27.672	46.000	18.328
3.559 MHz	26.259	56.000	29.741	18.967	46.000	27.033
12.090 MHz	20.452	60.000	39.548	15.137	50.000	34.863
23.363 MHz	26.727	60.000	33.273	18.997	50.000	31.003
23.826 MHz	25.497	60.000	34.503	18.107	50.000	31.893
24.215 MHz	24.660	60.000	35.340	16.949	50.000	33.051

Test Personnel:	Brian Lackey	Test Date:	3/23/2016
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart B		
Input Voltage:	5VDC (Charging)	Ambient Temperature:	21.0 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	**12.4** **%**

12.5 Results (Line 2, Idle)

Quasi-Peak and Average Measurements:



Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
152.700 KHz	52.730	65.923	13.193	37.166	55.923	18.757
236.300 KHz	37.173	63.534	26.361	21.191	53.534	32.343
324.400 KHz	34.352	61.017	26.665	20.325	51.017	30.692
439.100 KHz	31.896	57.740	25.844	21.558	47.740	26.182
3.429 MHz	29.399	56.000	26.601	20.379	46.000	25.621
15.605 MHz	32.490	60.000	27.510	26.207	50.000	23.793
17.409 MHz	26.837	60.000	33.163	19.266	50.000	30.734
18.496 MHz	28.958	60.000	31.042	21.590	50.000	28.410
23.570 MHz	25.480	60.000	34.520	19.127	50.000	30.873
25.508 MHz	16.832	60.000	43.168	11.181	50.000	38.819

Test Personnel:	Brian Lackey	Test Date:	3/23/2016
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart B		
Input Voltage:	5VDC (Charging)	Ambient Temperature:	21.0 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	**12.6** **%**

13 Antenna Requirement per FCC Part 15.203

13.1 Test Limits

§ 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, or §15.221. 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.

13.2 Results:

The sample tested met the antenna requirement. The antenna used was permanently attached and integral to the PCB.

14 Measurement Uncertainty

The measured value related to the corresponding limit will be used to decide whether the equipment meets the requirements.

The measurement uncertainty figures were calculated and correspond to a coverage factor of k = 2, providing a confidence level of respectively 95.45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian).

Measurement uncertainty Table

Parameter	Uncertainty	Notes
Radiated emissions, 30 to 1000 MHz	±3.9dB	
Radiated emissions, 1 to 18 GHz	±4.2dB	
Radiated emissions, 18 to 40 GHz	±4.3dB	
Power Port Conducted emissions, 150kHz to 30 MHz	±2.8dB	

15 Revision History

Revision Level	Date	Report Number	Notes
0	3/8/2017	102921149LEX-001	Original Issue