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EMC TEST REPORT

Report Number: **103030302LEX-001**
Project Number: **G103030302**

Report Issue Date: **7/5/2017**

Product Name: **GoTenna MESH**

Standards: **Title 47 CFR Part 15 Subpart C,**
RSS-247 Issue 2

Tested by:
Intertek Testing Services NA, Inc.
731 Enterprise Drive
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Client:
GoTenna
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Report prepared by

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TABLE OF CONTENTS

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
10	Occupied Bandwidth	§ 15.247(a)(1)(i)	RSS-247 (5.1.1)	Pass
17	Channel Separation	§ 15.247(a)(1)	RSS-247 (5.1.2)	Pass
19	Number of Hopping Channels	§ 15.247(a)(1)(iii)	RSS-247 (5.1.3)	Pass
21	Time of Occupancy	§ 15.247(a)(1)(iii)	RSS-247 (5.1.3)	Pass
17	Conducted Spurious Emissions	§ 15.247(d)	RSS-247 (5.5)	Pass
27	Radiated Spurious Emissions (Transmitter)	§ 15.247(d), § 15.209, and § 15.205	RSS-247 (5.5)	Pass
33	Radiated Spurious Emissions (Receiver)	§ 15.109	RSS-Gen (6.1)	Pass
36	AC Powerline Conducted Emissions	§ 15.107, § 15.207	RSS-Gen (7.2.4)	Pass
42	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	GoTenna
Model Number	GoTenna MESH
Serial Number	Test Sample 1
Receive Date	5/19/2017
Test Start Date	5/19/2017
Test End Date	6/20/2017
Device Received Condition	Good
Test Sample Type	Production
Frequency Band	902.5MHz-927.5MHz
Modulation Type	2GFSK
Duty Cycle	100%
Transmission Control	Test Commands
Maximum Output Power	29.44 dBm
Test Channels	902.5MHz, 915MHz, 927.5MHz
Antenna Type (15.203)	Internal Antenna
Maximum Antenna Gain [1]	1.0 dBi Peak Gain

Description of Equipment Under Test
The test sample was a device that pairs with a smart phone and uses the goTenna app to communicate off-grid. The unit is battery powered and charged via a USB port

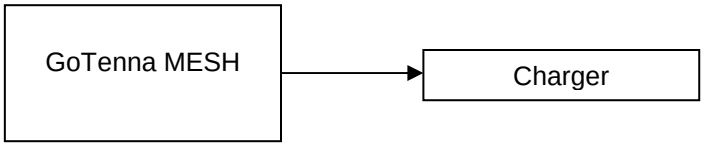
Operating modes of the EUT:

No.	Descriptions of EUT Exercising
1	Transmitting on low, mid, or high channel
2	Frequency hopping mode within 902.5MHz-927.5MHz

[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:

No support equipment was used in this evaluation.

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.

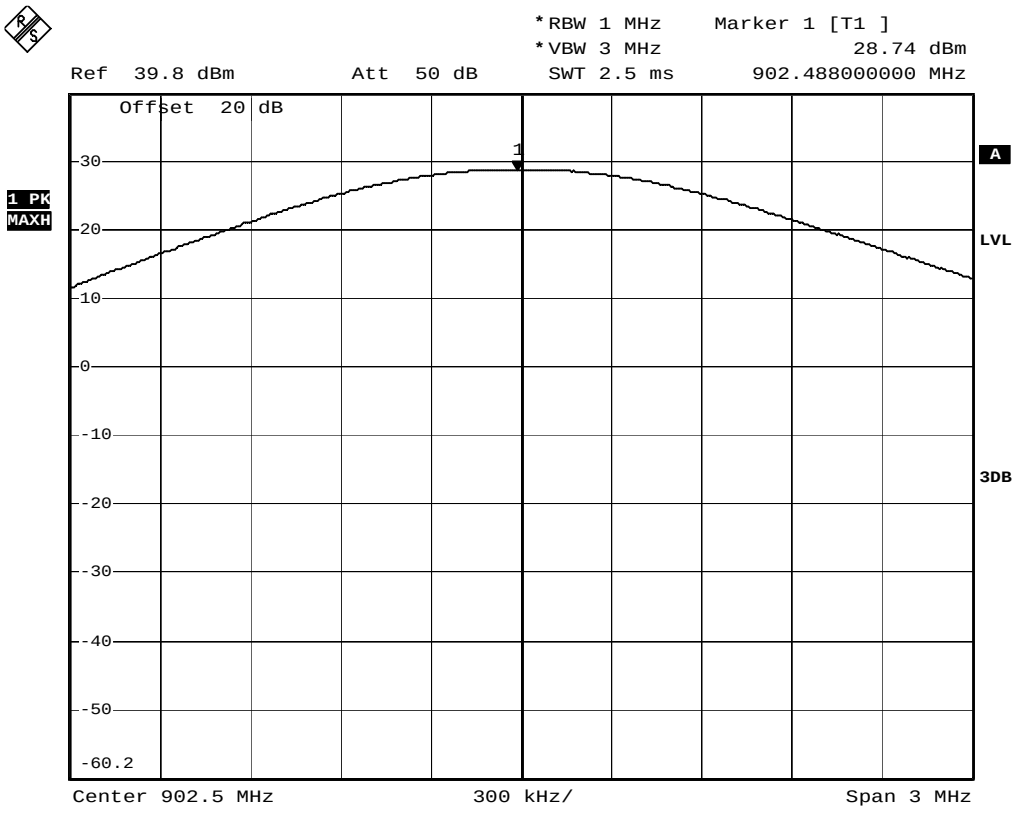
4.3 Test Equipment Used:

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.

Frequency (MHz)	Type	Measured Power (dBm)	Limit (dBm)	Margin (dB)
902.5	Peak	28.74	30	1.26
915	Peak	29.21	30	0.97
927.5	Peak	29.44	30	0.56



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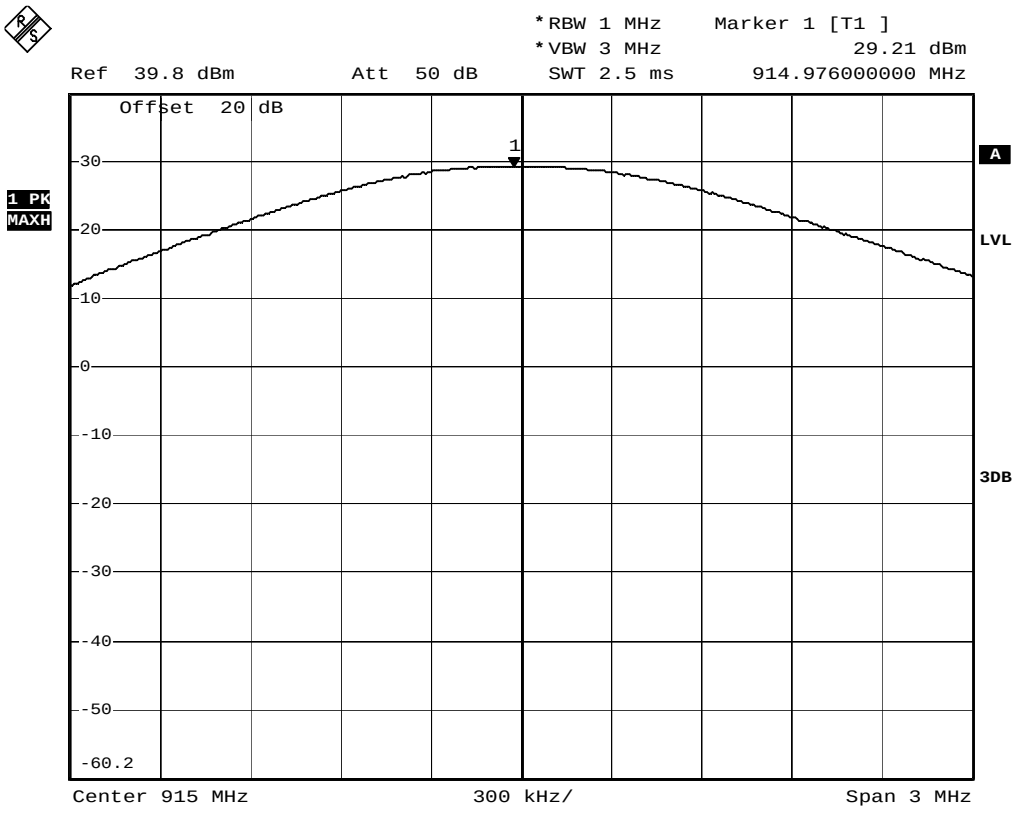

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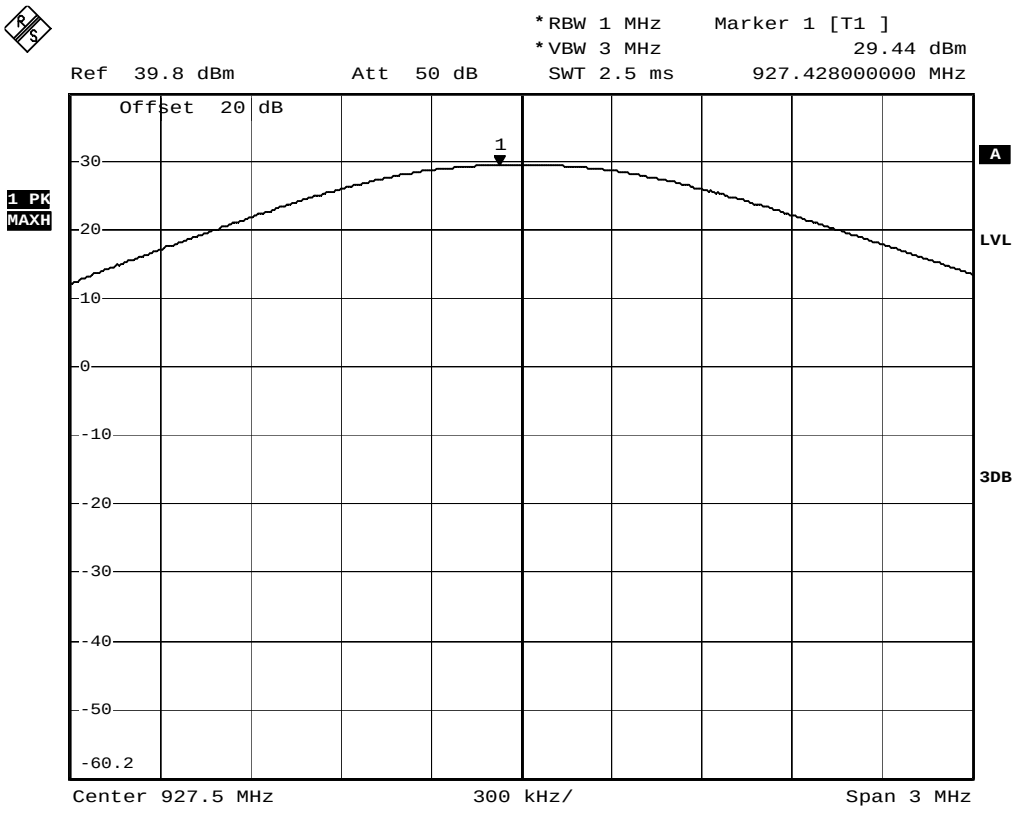


Date: 29.MAY.2017 11:04:12

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

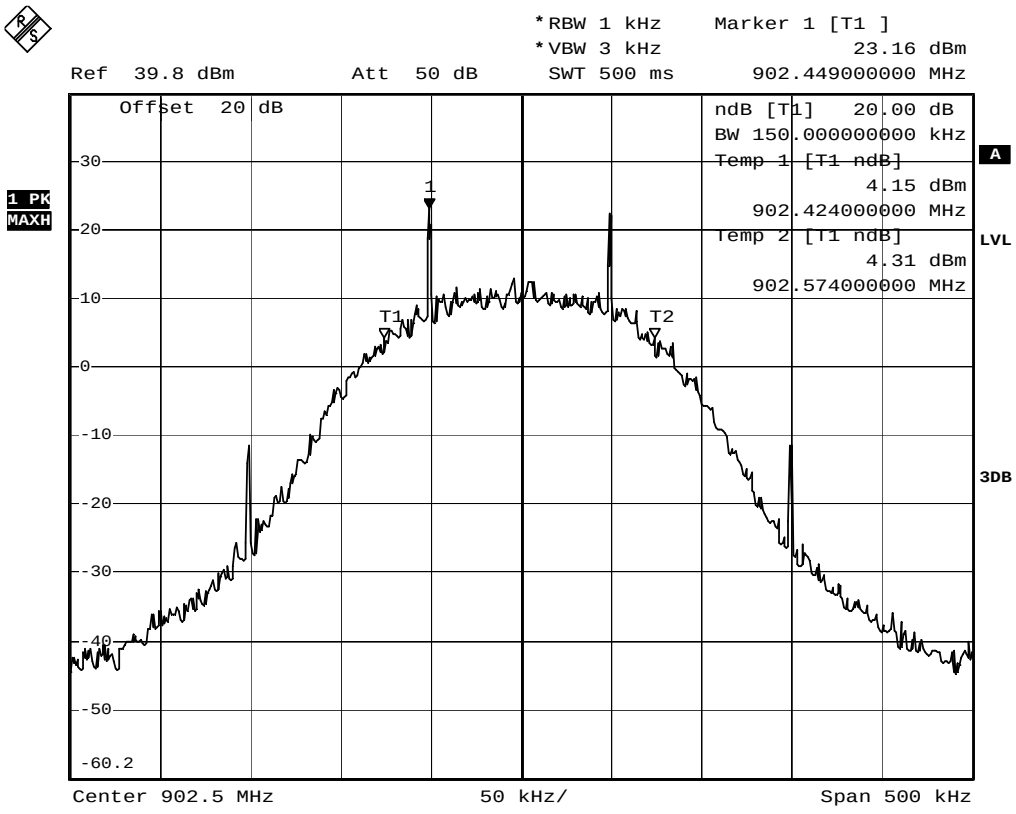
ANSI C63.10: 2013 and KDB Publication No. 558074 D01 v03r05: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

5.3 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2016	9/20/2017

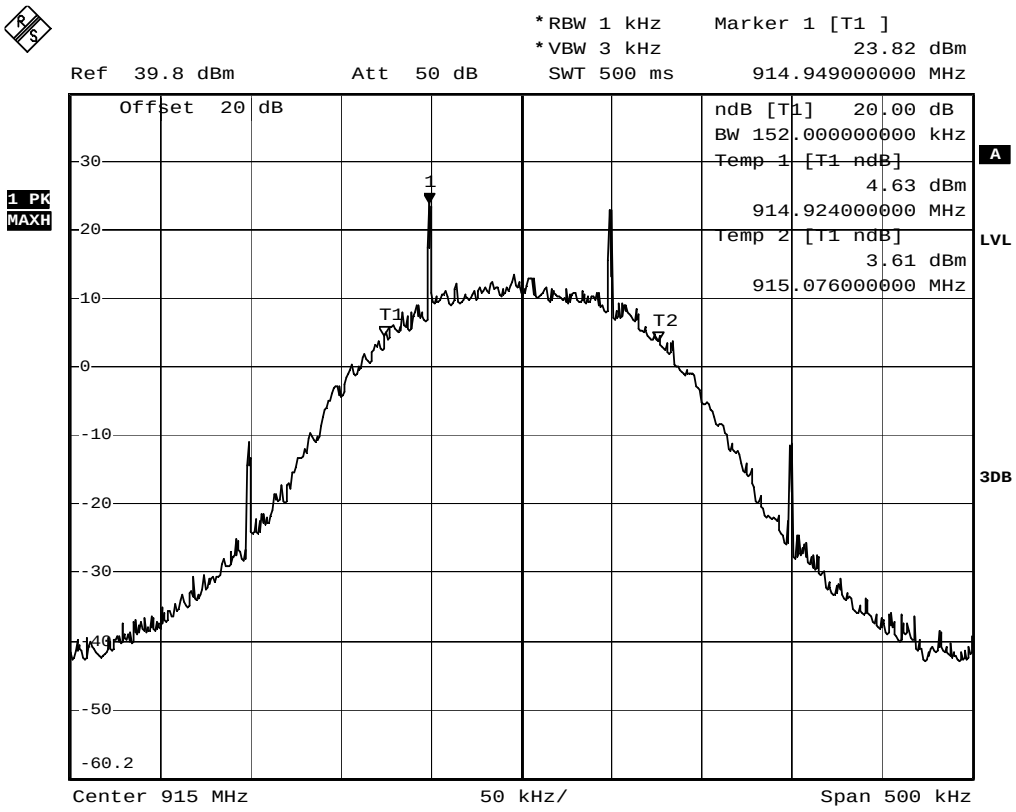
5.4 Results:

Frequency (MHz)	20dB Bandwidth	99% Power Bandwidth	Result
902.5	150kHz	180kHz	Pass
915	152kHz	180kHz	Pass
927.5	148kHz	179kHz	Pass



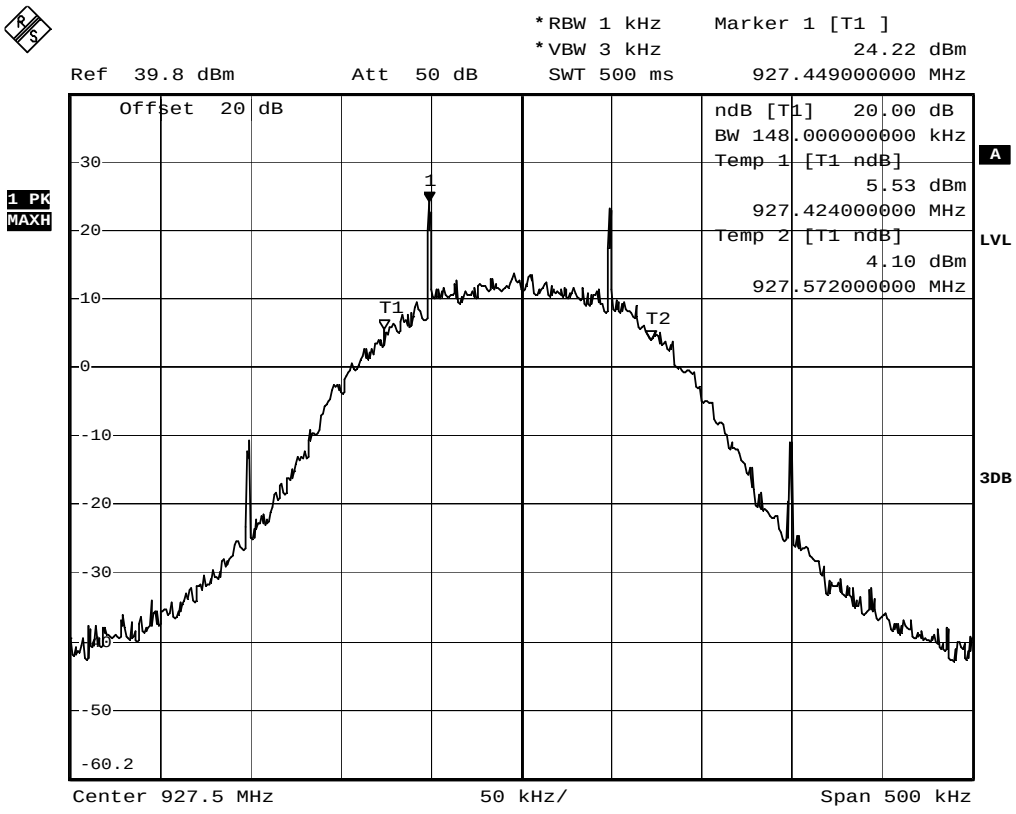
Date: 29.MAY.2017 11:31:19

20dB Bandwidth, 902.5MHz



Date: 29.MAY.2017 11:32:03

20dB Bandwidth, 915MHz



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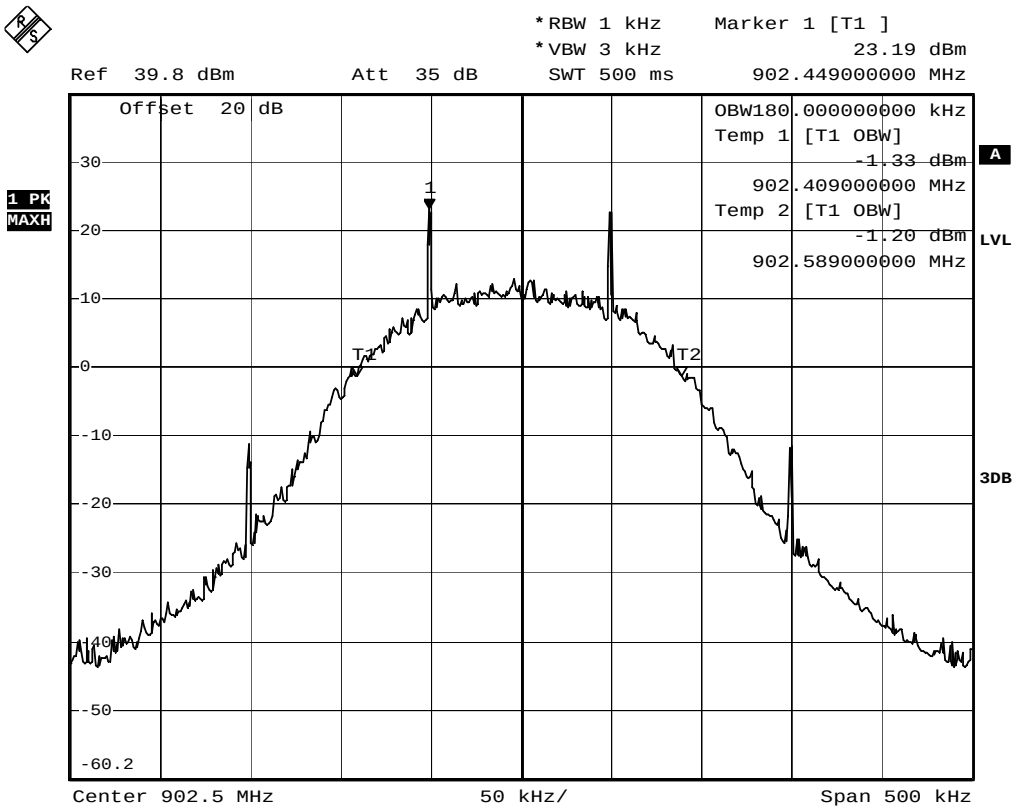
20dB Bandwidth, 927.5MHz



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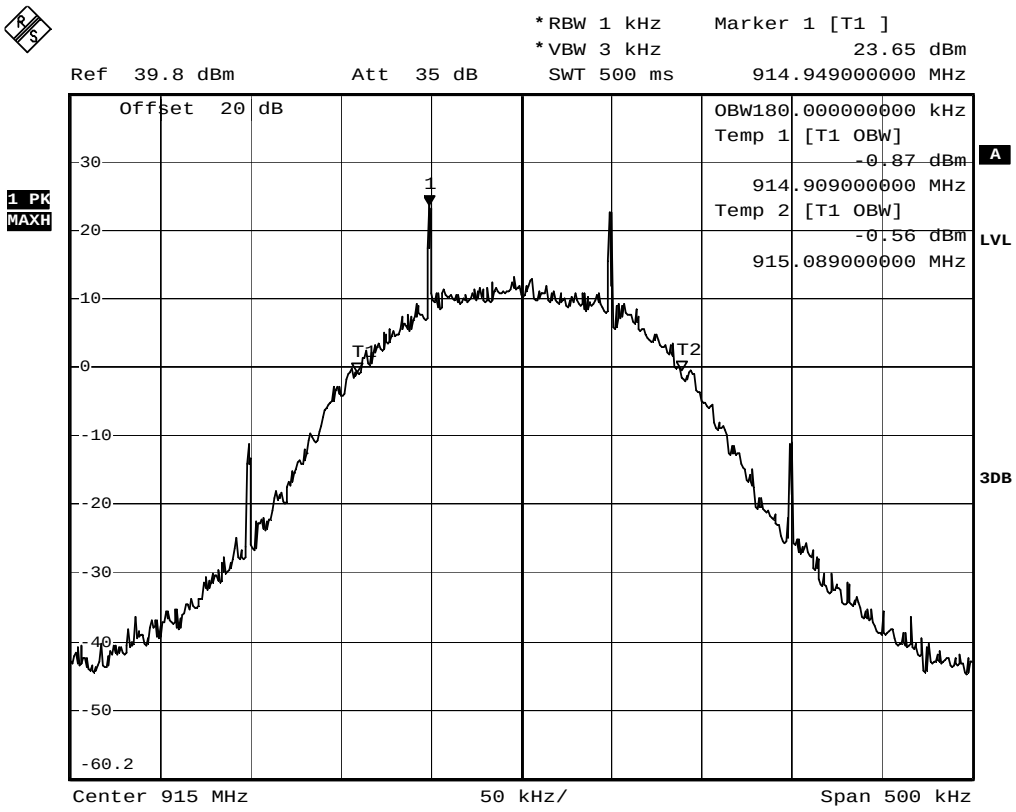
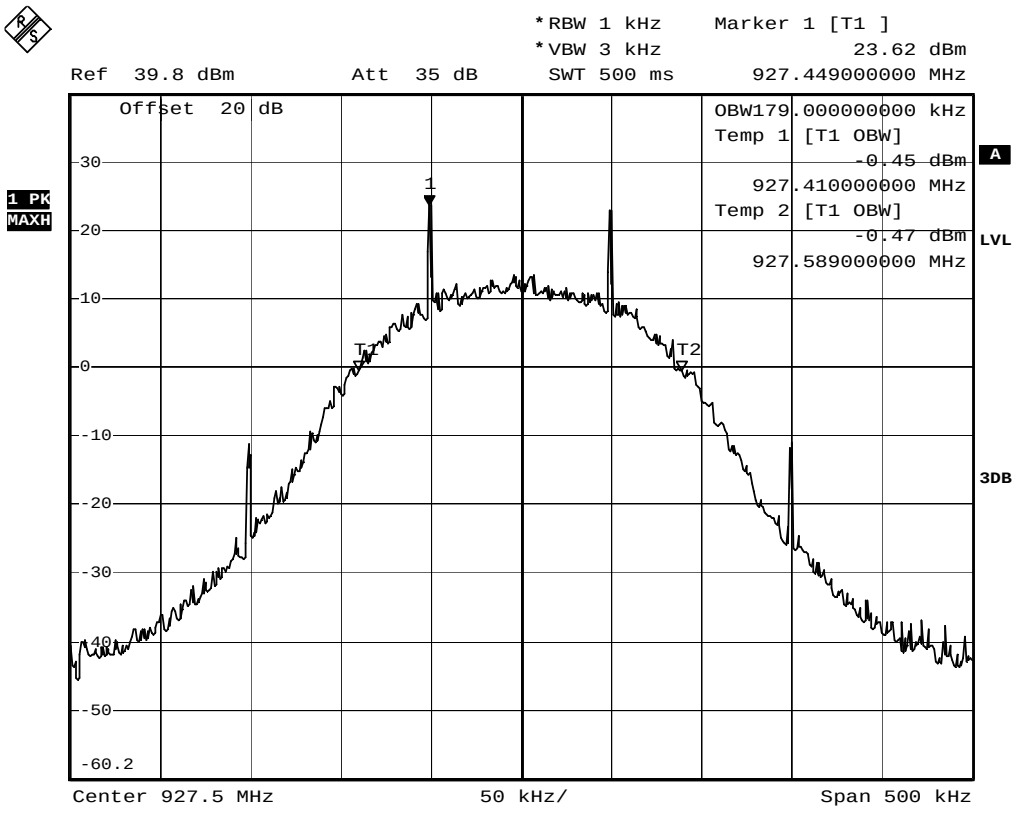
99% Power Bandwidth, 902.5MHz



Date: 29.MAY.2017 11:36:04

99% Power Bandwidth, 915 MHz



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99% Power Bandwidth, 927.5MHz

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

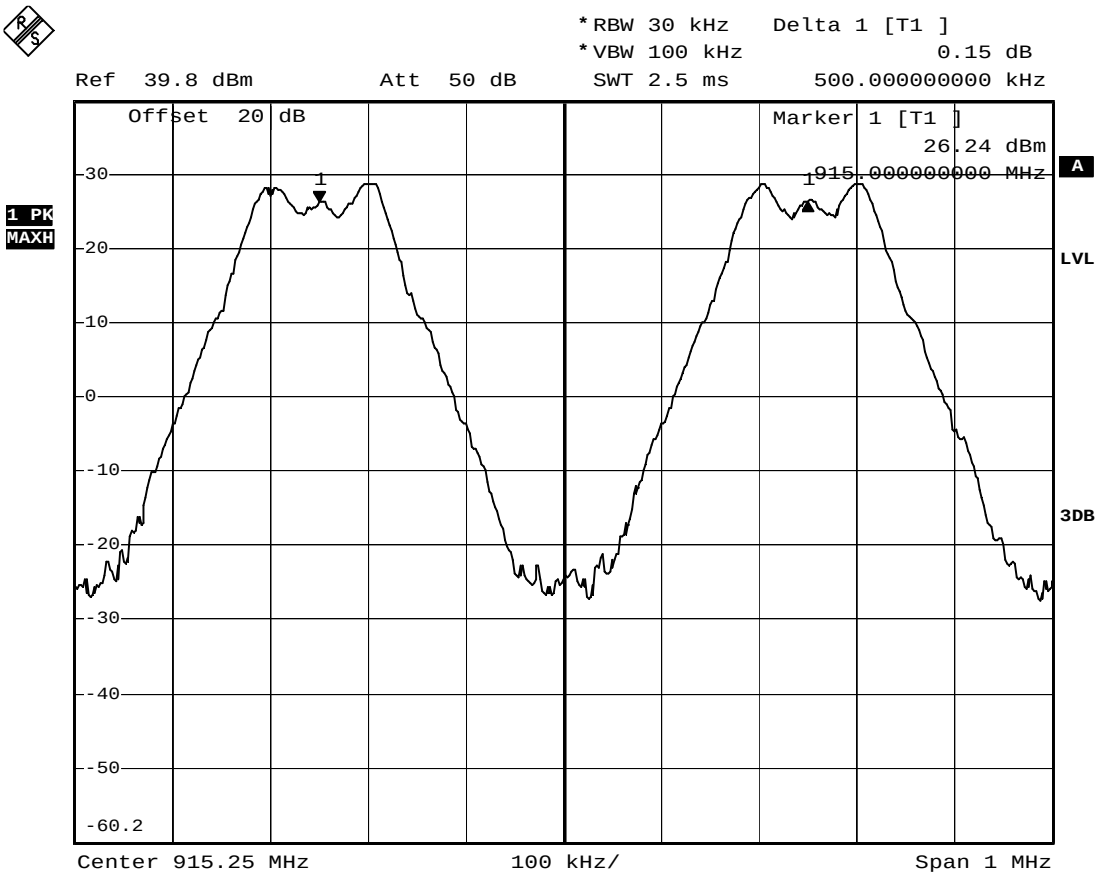
ANSI C63.10: 2013 and FCC Public Notice DA 00-705 Released March 30, 2000: Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

6.3 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2016	9/20/2017

6.4 Results:

The plot below shows that the carrier frequency separation is 500kHz.



Date: 29.MAY.2017 11:09:43

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

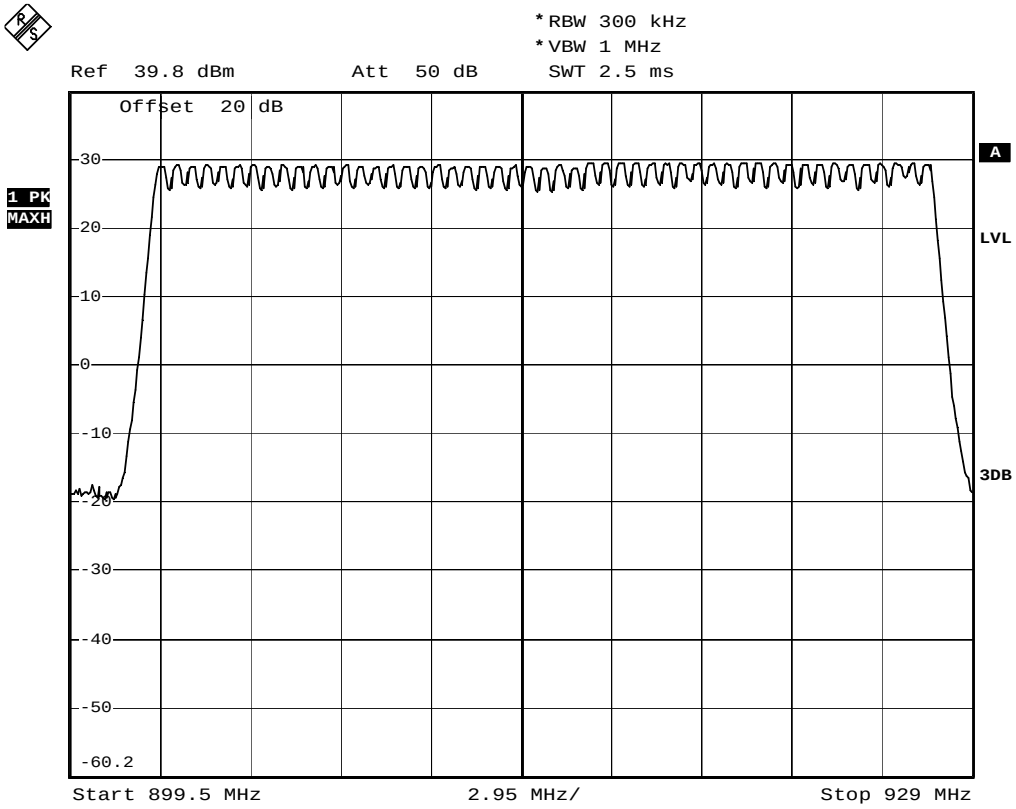
ANSI C63.10: 2013 and FCC Public Notice DA 00-705 Released March 30, 2000: Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

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 51 hopping frequencies channels being used. The middle of the hopping spectrum was filtered out in order to avoid potential interference with some cordless phones.



Date: 29.MAY.2017 11:11:10

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

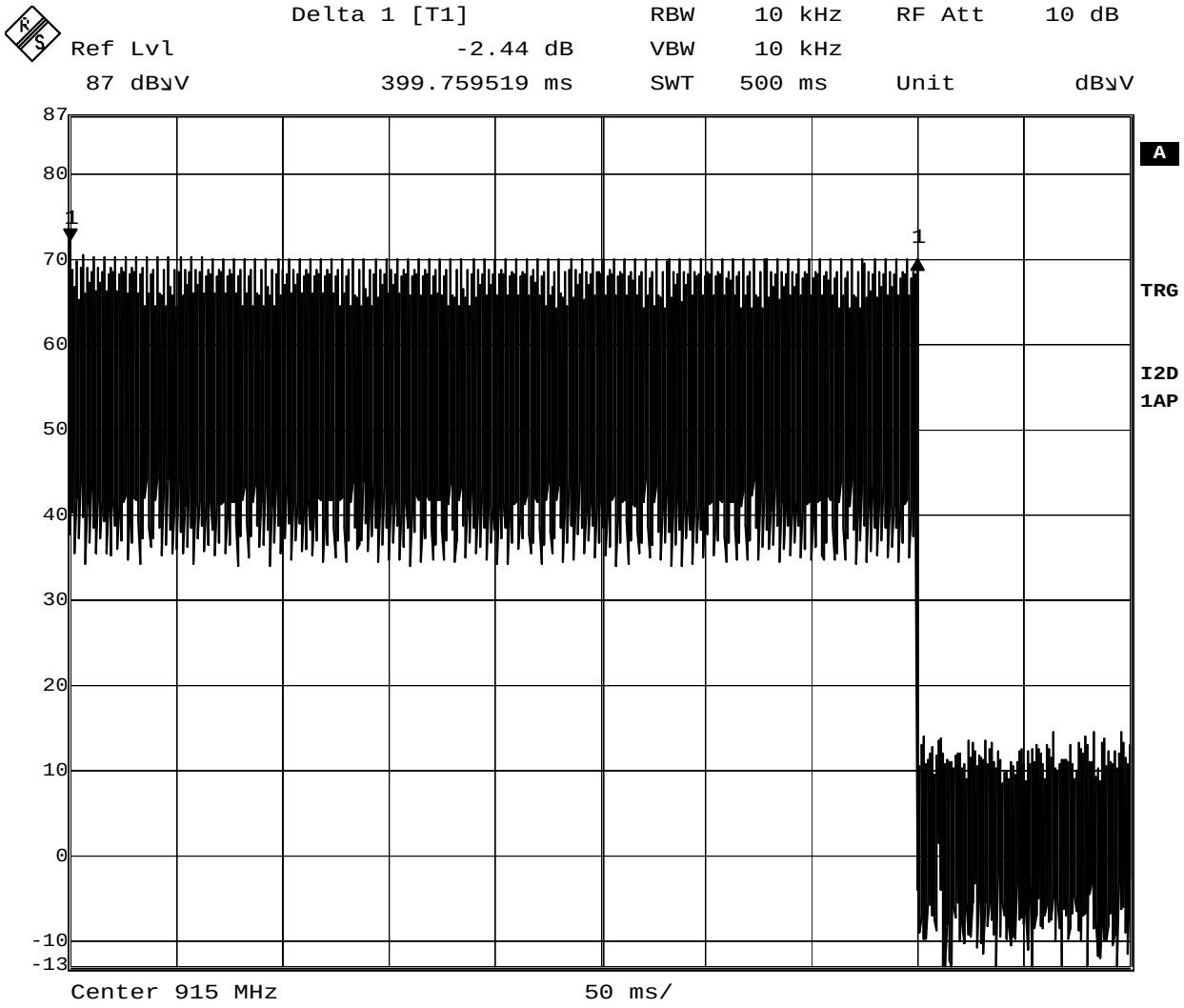
ANSI C63.10: 2013 and FCC Public Notice DA 00-705 Released March 30, 2000: Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

8.3 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2016	9/20/2017

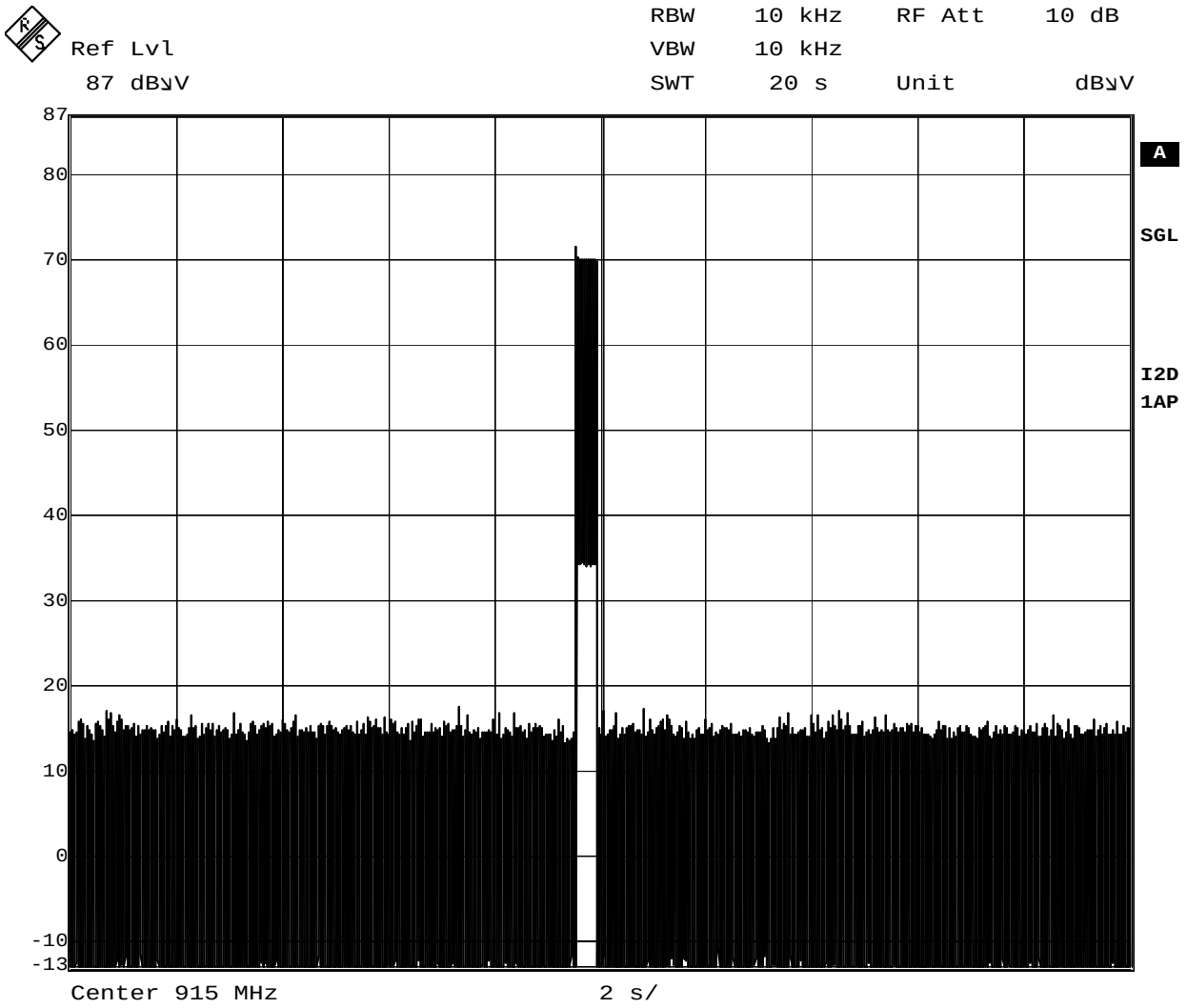
8.4 Results:

The time of occupancy calculations are shown below. The plots which follow illustrate the on time of the pulses and the number of pulse trains in 20 seconds. The total "on" time is less than the 399.7mS limit for this product.



Date: 5.JUN.2017 14:59:24

On Time of 399.7mS per Pulse



Date: 5.JUN.2017 15:00:47

1 Pulses in 20 Seconds

Average Time of Occupancy (over 20 sec) is 399.7mS x 1 Pulses = 399.7mS

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

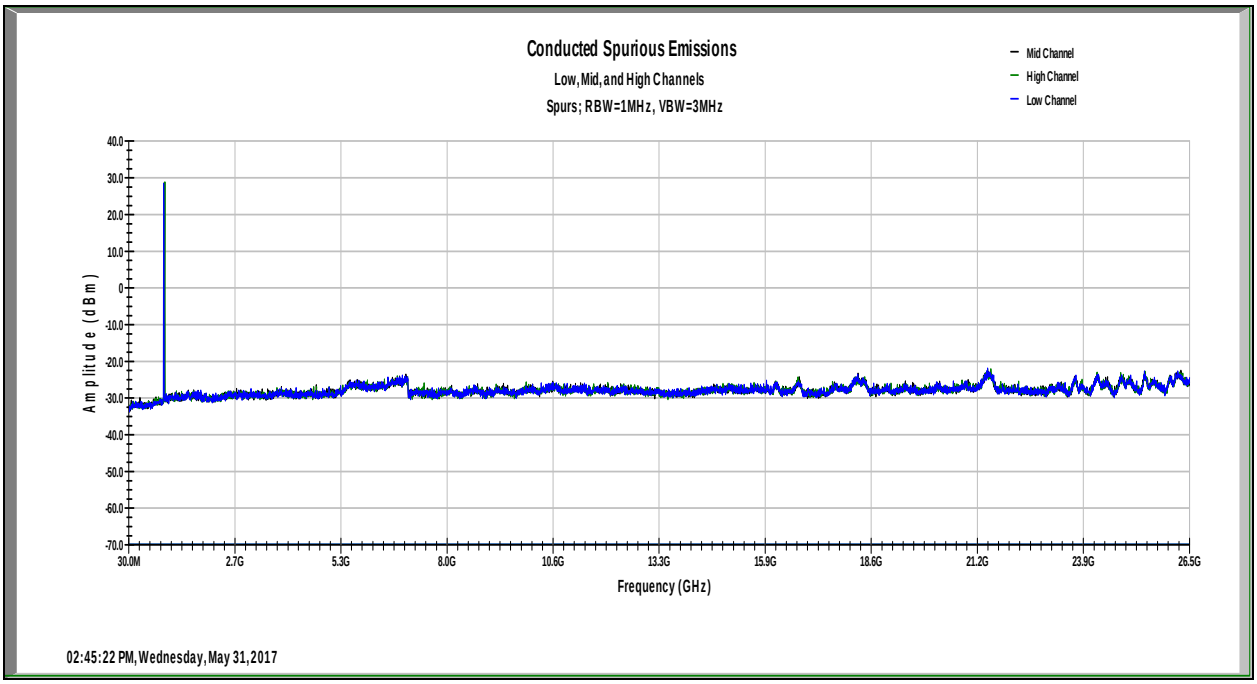
ANSI C63.10: 2013 and KDB Publication No. 558074 D01 v03r05: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

9.3 Test Equipment Used:

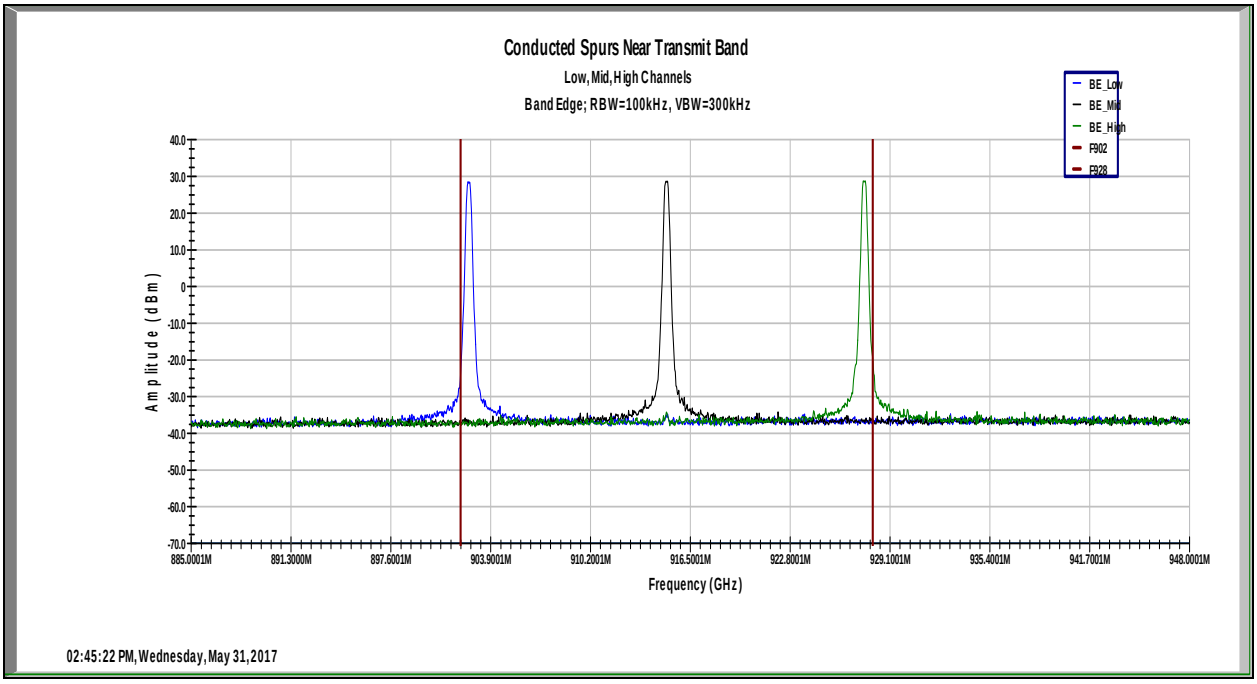
Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	9/20/2016	9/20/2017

9.4 Results:

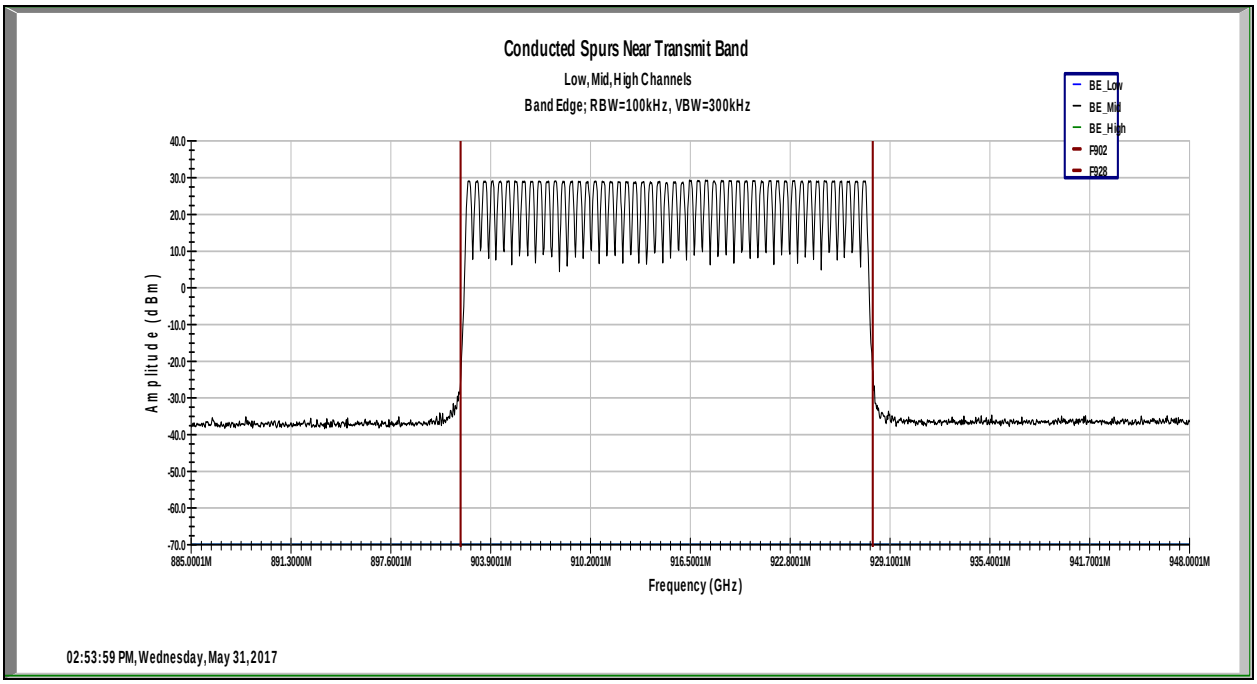
The following plots show that there are no conducted spurious emissions exceeding the 20dB down criteria.



Conducted Spurious Emissions – 30 MHz to 26.5 GHz



Emissions Close to Band Edge (Low, Mid, and High Channels)



Emissions Close to Band Edge (Hopping)

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	4/6/2017	4/6/2018
Horn Antenna	00156319	ETS	3117	11/14/2016	11/14/2017
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.

902.5MHz Spurious Measurements

Final_Result_PK+

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1805.000000	62.40	74.00	11.60	1000.000	208.0	V	144.0	0.5
2707.500000	43.21	74.00	30.79	1000.000	376.0	H	340.0	4.1
3610.000000	44.67	74.00	29.33	1000.000	197.0	H	346.0	5.6
4512.100000	43.05	74.00	30.95	1000.000	261.0	H	276.0	7.7
5415.000000	44.60	74.00	29.40	1000.000	202.0	H	0.0	9.2
6317.500000	44.79	74.00	29.21	1000.000	290.0	H	120.0	9.9
7220.000000	46.07	74.00	27.93	1000.000	324.0	H	343.0	10.4
8122.900000	45.07	74.00	28.93	1000.000	256.0	H	158.0	11.3
9023.000000	45.19	74.00	28.81	1000.000	229.0	V	125.0	12.4

Final_Result_AVG

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1805.000000	40.16	54.00	13.84	1000.000	208.0	V	144.0	0.5
2707.500000	33.26	54.00	20.74	1000.000	376.0	H	340.0	4.1
3610.000000	37.21	54.00	16.79	1000.000	197.0	H	346.0	5.6
4512.100000	29.78	54.00	24.22	1000.000	261.0	H	276.0	7.7
5415.000000	32.89	54.00	21.11	1000.000	202.0	H	0.0	9.2
6317.500000	31.60	54.00	22.40	1000.000	290.0	H	120.0	9.9
7220.000000	33.39	54.00	20.61	1000.000	324.0	H	343.0	10.4
8122.900000	32.51	54.00	21.49	1000.000	256.0	H	158.0	11.3
9023.000000	33.04	54.00	20.96	1000.000	229.0	V	125.0	12.4

Test Personnel:	Carmen Davis	Test Date:	5/19/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart B		
Input Voltage:	Attached to Charger	Ambient Temperature:	21.0 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	43.6.0 %

915MHz Spurious Measurements

Final_Result_PK+

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1830.000000	47.04	74.00	26.96	1000.000	220.0	V	0.0	0.7
2745.000000	42.21	74.00	31.79	1000.000	205.0	H	339.0	4.2
3660.000000	46.93	74.00	27.07	1000.000	297.0	H	342.0	5.7
4574.600000	42.84	74.00	31.16	1000.000	227.0	H	288.0	7.7
5490.000000	45.87	74.00	28.13	1000.000	312.0	V	0.0	9.4
6405.000000	44.35	74.00	29.65	1000.000	202.0	H	126.0	10.3
7320.000000	44.98	74.00	29.02	1000.000	237.0	H	0.0	10.5
8235.000000	44.60	74.00	29.40	1000.000	250.0	H	121.0	11.4
9149.600000	46.14	74.00	27.86	1000.000	410.0	V	286.0	12.7

Final_Result_AVG

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1830.000000	40.00	54.00	14.00	1000.000	220.0	V	0.0	0.7
2745.000000	33.75	54.00	20.25	1000.000	205.0	H	339.0	4.2
3660.000000	36.79	54.00	17.21	1000.000	297.0	H	342.0	5.7
4574.600000	29.55	54.00	24.45	1000.000	227.0	H	288.0	7.7
5490.000000	35.23	54.00	18.77	1000.000	312.0	V	0.0	9.4
6405.000000	31.67	54.00	22.33	1000.000	202.0	H	126.0	10.3
7320.000000	32.67	54.00	21.33	1000.000	237.0	H	0.0	10.5
8235.000000	32.25	54.00	21.75	1000.000	250.0	H	121.0	11.4
9149.600000	33.21	54.00	20.79	1000.000	410.0	V	286.0	12.7

Test Personnel:	Carmen Davis	Test Date:	5/19/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart B		
Input Voltage:	Attached to Charger	Ambient Temperature:	21.0 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	43.6.0 %

927.5MHz Spurious Measurements

Final_Result_PK+

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1855.000000	70.49	74.00	3.51	1000.000	249.0	V	340.0	0.8
2782.500000	43.37	74.00	30.63	1000.000	341.0	H	308.0	4.2
3710.400000	40.91	74.00	33.09	1000.000	202.0	V	343.0	5.7
4637.500000	42.61	74.00	31.39	1000.000	206.0	H	324.0	7.7
5565.000000	45.28	74.00	28.72	1000.000	229.0	V	340.0	9.5
6492.100000	45.06	74.00	28.94	1000.000	216.0	V	326.0	10.5
7420.000000	44.94	74.00	29.06	1000.000	268.0	H	322.0	10.8
8347.500000	44.63	74.00	29.37	1000.000	410.0	V	245.0	11.4
9275.000000	47.13	74.00	26.87	1000.000	321.0	V	336.0	12.8

Final_Result_AVG

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1855.000000	39.88	54.00	14.12	1000.000	249.0	V	340.0	0.8
2782.500000	35.61	54.00	18.39	1000.000	341.0	H	308.0	4.2
3710.400000	28.82	54.00	25.18	1000.000	202.0	V	343.0	5.7
4637.500000	30.04	54.00	23.96	1000.000	206.0	H	324.0	7.7
5565.000000	34.09	54.00	19.91	1000.000	229.0	V	340.0	9.5
6492.100000	33.02	54.00	20.98	1000.000	216.0	V	326.0	10.5
7420.000000	32.37	54.00	21.63	1000.000	268.0	H	322.0	10.8
8347.500000	31.70	54.00	22.30	1000.000	410.0	V	245.0	11.4
9275.000000	34.30	54.00	19.70	1000.000	321.0	V	336.0	12.8

Test Personnel:	Carmen Davis	Test Date:	5/19/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart B		
Input Voltage:	Attached to Charger	Ambient Temperature:	21.0 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	43.6.0 %

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

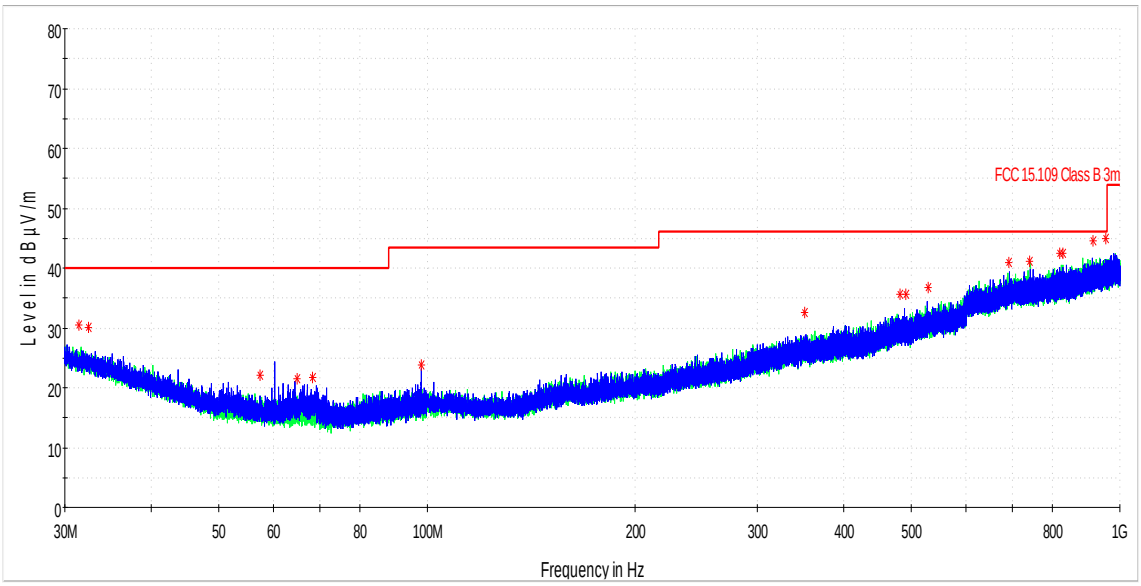
FS = 19.48 + 18.52 + 0.78 = 38.78 dBµV/m
Level in µV/m = Common Antilogarithm [(38.78 dBµV/m)/20] = 86.89 µV/m

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	4/6/2017	4/6/2018
Horn Antenna	00156319	ETS	3117	11/14/2016	11/14/2017
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:

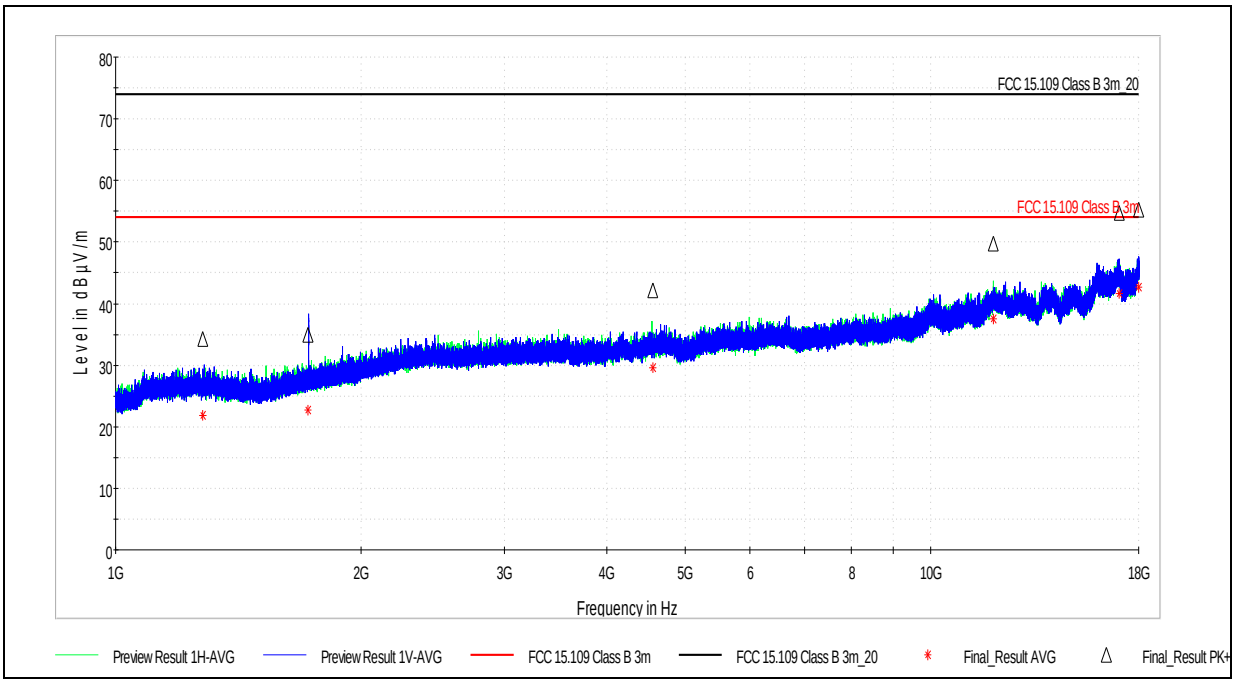
All spurious emissions with the test sample in receive mode were below the limits specified in Part 15.109 for a class B digital device and RSS-GEN Section 6.1.



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
31.440000	30.56	40.00	9.44	120.000	165.7	V	290.0	23.8
32.440000	30.05	40.00	9.95	120.000	308.6	V	164.0	23.4
57.395000	22.04	40.00	17.96	120.000	100.0	V	282.0	15.4
64.929000	21.61	40.00	18.39	120.000	165.6	V	264.0	15.0
68.405000	21.68	40.00	18.32	120.000	158.6	V	274.0	15.0
98.087000	23.77	43.52	19.75	120.000	147.0	V	265.0	17.0
350.760000	32.50	46.02	13.52	120.000	308.6	V	267.0	25.5
481.960000	35.55	46.02	10.47	120.000	220.3	H	92.0	28.4
491.040000	35.66	46.02	10.36	120.000	130.3	V	173.0	28.5
529.570000	36.78	46.02	9.24	120.000	123.1	V	127.0	29.5
691.820000	40.92	46.02	5.10	120.000	284.5	V	343.0	33.3
740.590000	41.10	46.02	4.92	120.000	198.0	H	165.0	33.4
819.420000	42.46	46.02	3.56	120.000	272.4	V	164.0	34.5
827.160000	42.54	46.02	3.48	120.000	401.4	H	310.0	34.5
915.440000	44.59	46.02	1.43	120.000	111.4	V	164.0	36.1
954.440000	45.04	46.02	0.98	120.000	401.6	H	7.0	36.2

Test Personnel:	Carmen Davis	Test Date:	5/19/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart B		
Input Voltage:	Attached to Charger	Ambient Temperature:	21.0 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	43.6.0 %



Final_Result_PK+

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1279.118500	34.29	74.00	39.71	1000.000	129.0	H	22.0	-1.1
1719.943500	34.96	74.00	39.04	1000.000	159.0	H	37.0	-0.2
4557.745000	42.14	74.00	31.86	1000.000	130.0	H	50.0	7.8
11929.371500	49.78	74.00	24.22	1000.000	161.0	H	50.0	17.4
17030.565500	54.67	74.00	19.33	1000.000	155.0	V	0.0	21.5
17988.125500	55.30	74.00	18.70	1000.000	146.0	V	0.0	22.9

Final_Result_AVG

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1279.118500	21.81	54.00	32.19	1000.000	129.0	H	22.0	-1.1
1719.943500	22.76	54.00	31.24	1000.000	159.0	H	37.0	-0.2
4557.745000	29.57	54.00	24.43	1000.000	130.0	H	50.0	7.8
11929.371500	37.50	54.00	16.50	1000.000	161.0	H	50.0	17.4
17030.565500	41.70	54.00	12.30	1000.000	155.0	V	0.0	21.5
17988.125500	42.63	54.00	11.37	1000.000	146.0	V	0.0	22.9

Test Personnel:	Carmen Davis	Test Date:	5/19/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart B		
Input Voltage:	Attached to Charger	Ambient Temperature:	21.0 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	43.6.0 %

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

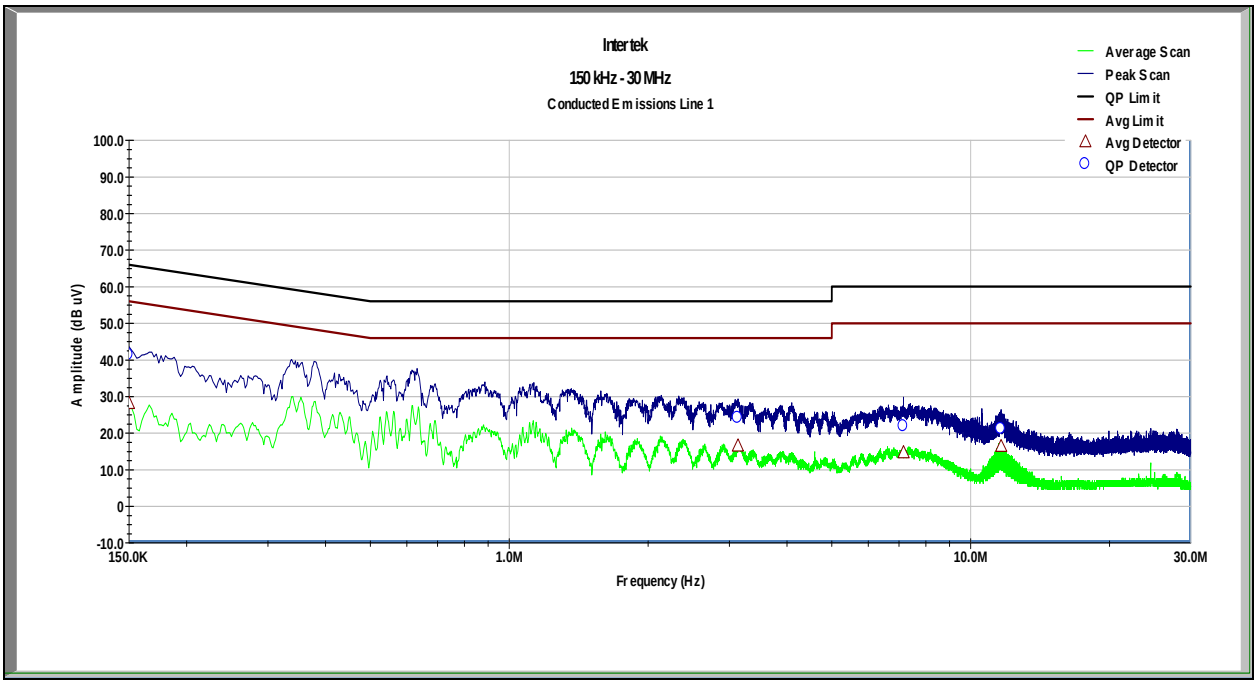
ANSI C63.4: 2014

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	3333	Teseq	NNB52	6/15/2017	6/15/2018

12.4 Results (Line 1, Transmitting):

Quasi-Peak and Average Measurements:



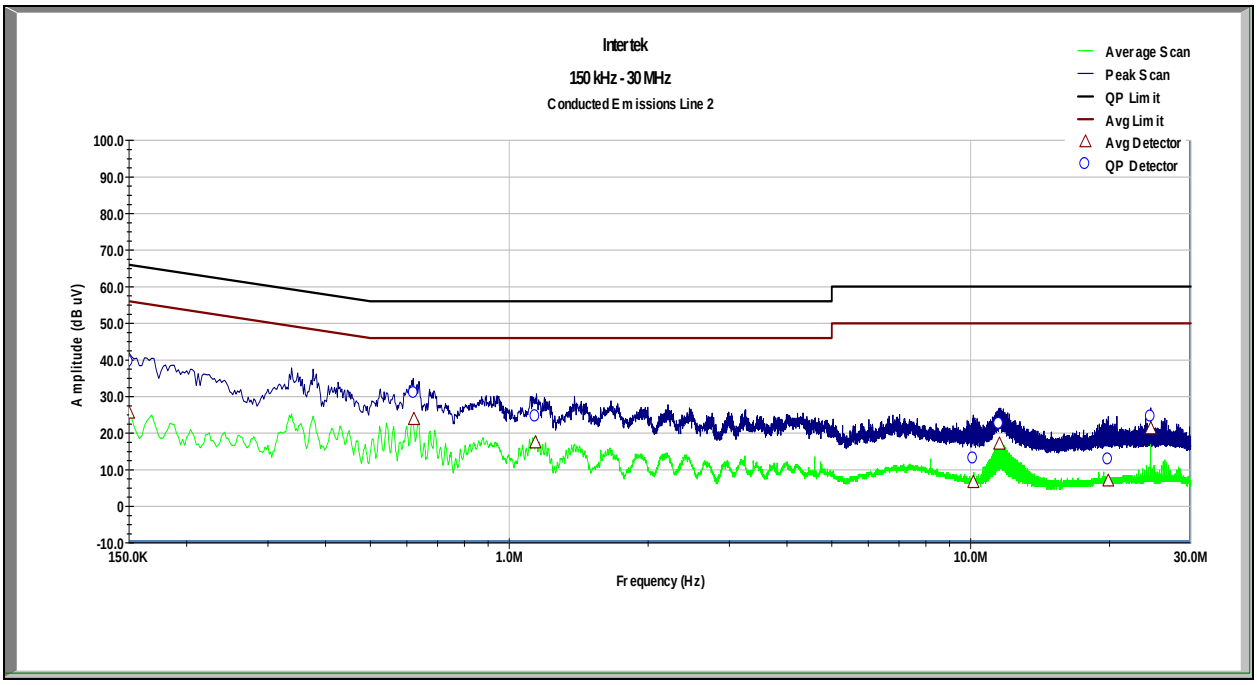
Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
150.000 KHz	41.282	66.000	24.718	28.117	56.000	27.883
3.133 MHz	24.099	56.000	31.901	16.476	46.000	29.524
7.159 MHz	21.776	60.000	38.224	14.664	50.000	35.336
11.649 MHz	21.060	60.000	38.940	16.397	50.000	33.603

Transmitting, Line 1

Test Personnel:	Carmen Davis	Test Date:	5/20/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart B		
Input Voltage:	Connected to Charger	Ambient Temperature:	22.3 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	53.2%

12.5 Results (Line 2, Transmitting)

Quasi-Peak and Average Measurements:



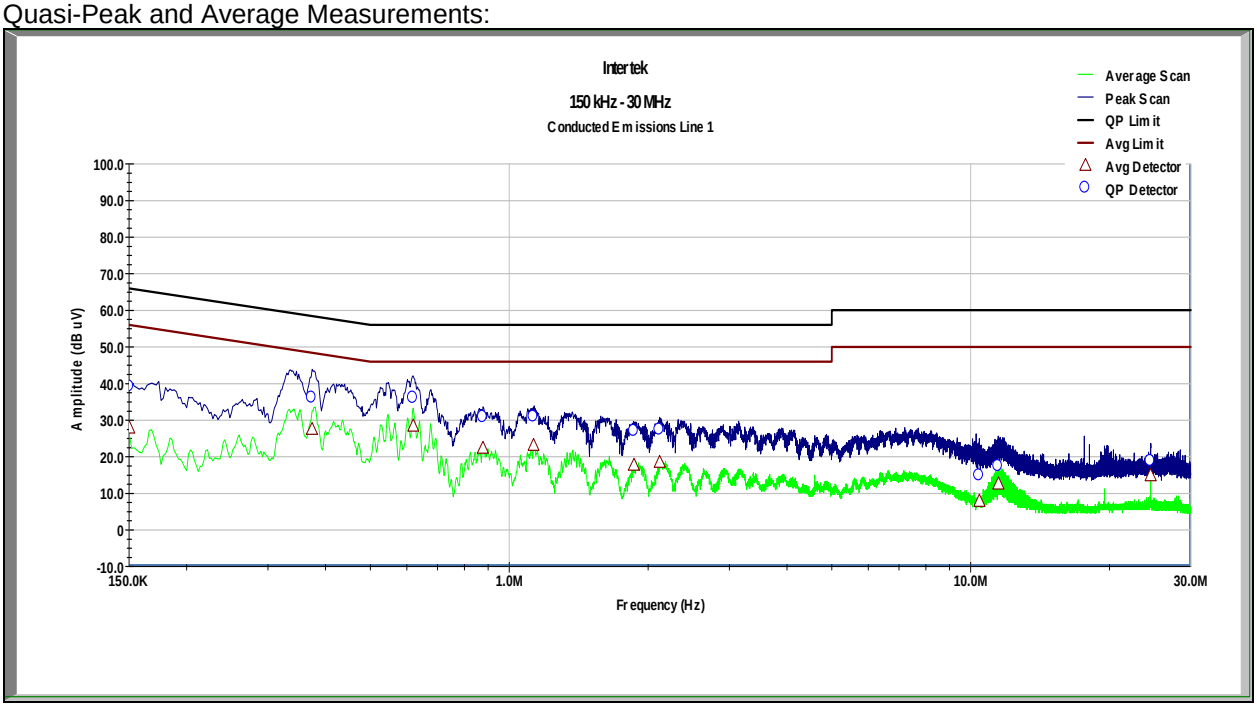
Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
150.000 KHz	39.353	66.000	26.647	25.479	56.000	30.521
622.100 KHz	30.850	56.000	25.150	23.770	46.000	22.230
1.140 MHz	24.397	56.000	31.603	17.386	46.000	28.614
10.138 MHz	12.972	60.000	47.028	6.553	50.000	43.447
11.544 MHz	22.406	60.000	37.594	17.003	50.000	32.997
19.887 MHz	12.665	60.000	47.335	6.929	50.000	43.071
24.576 MHz	24.374	60.000	35.626	21.229	50.000	28.771

Transmitting, Line 2

Test Personnel:	Carmen Davis	Test Date:	5/20/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart B		
Input Voltage:	Connected to Charger	Ambient Temperature:	22.3 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	53.2%

12.6 Results (Line 1, Idle)

Quasi-Peak and Average Measurements:



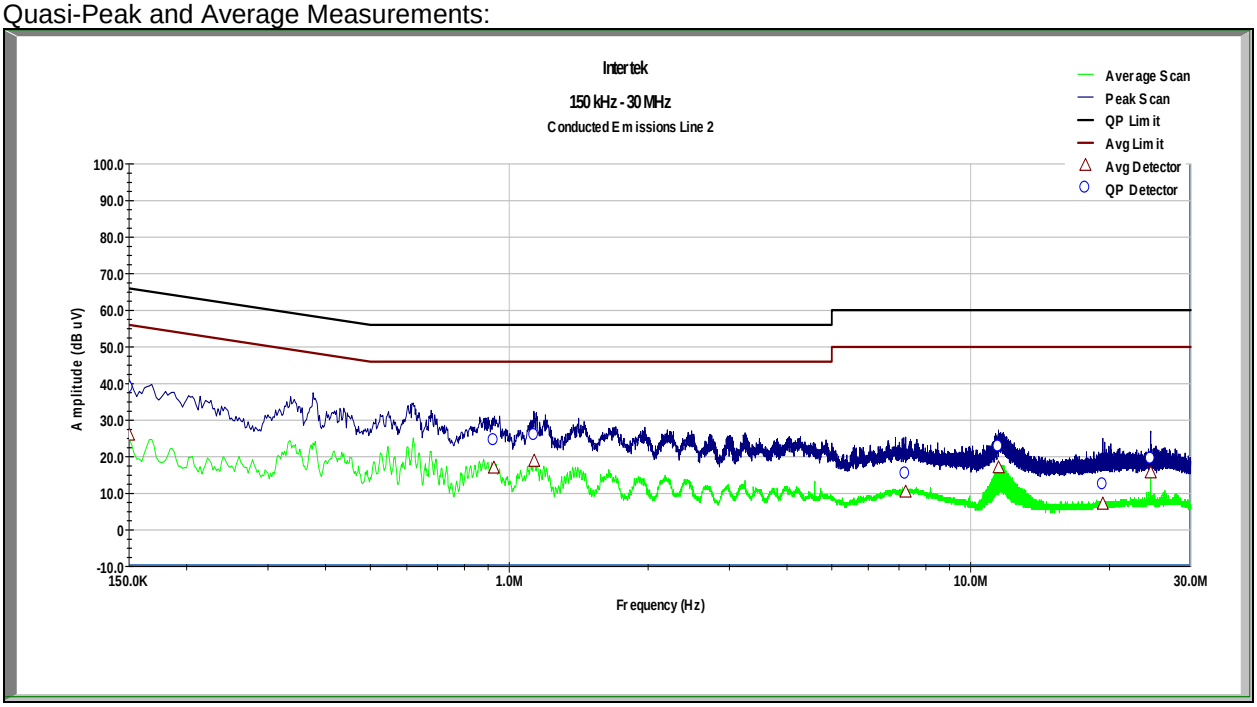
Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Margin (dB)	Average (dBuV)	Average Limit (dBuV)	Average Margin (dB)
150.300 KHz	39.101	65.991	26.891	27.877	55.991	28.115
374.100 KHz	36.072	59.597	23.526	27.476	49.597	22.121
619.700 KHz	35.951	56.000	20.049	28.379	46.000	17.621
877.200 KHz	30.702	56.000	25.298	22.327	46.000	23.673
1.130 MHz	30.802	56.000	25.198	23.122	46.000	22.878
1.864 MHz	26.920	56.000	29.080	17.700	46.000	28.300
2.120 MHz	27.250	56.000	28.750	18.495	46.000	27.505
10.450 MHz	14.771	60.000	45.229	7.845	50.000	42.155
11.488 MHz	17.341	60.000	42.659	12.573	50.000	37.427
24.574 MHz	18.668	60.000	41.332	14.837	50.000	35.163

Idle Mode, Line 1

Test Personnel:	Carmen Davis	Test Date:	5/20/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart B		
Input Voltage:	Connected to Charger	Ambient Temperature:	22.3 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	53.2%

12.7 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)
150.000 KHz	38.741	66.000	27.259	25.964	56.000	30.036
926.500 KHz	24.382	56.000	31.618	16.899	46.000	29.101
1.134 MHz	25.772	56.000	30.228	18.789	46.000	27.211
7.231 MHz	15.260	60.000	44.740	10.319	50.000	39.681
11.499 MHz	22.629	60.000	37.371	16.968	50.000	33.032
19.355 MHz	12.299	60.000	47.701	7.084	50.000	42.916
24.576 MHz	19.377	60.000	40.623	15.589	50.000	34.411

Idle Mode, Line 2

Test Personnel:	Carmen Davis	Test Date:	5/20/2017
Supervising/Reviewing Engineer: (Where Applicable)	NA	Limit Applied:	Class B
Product Standard:	FCC Part 15 Subpart B		
Input Voltage:	Connected to Charger	Ambient Temperature:	22.3 ºC
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Relative Humidity:	53.2%

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	7/5/2017	103030302LEX-001	Original Issue