Testing Tomorrow's Technology

Application
For

Part 2, Subpart J, Paragraph 2.907 Equipment Authorization of Certification for an Intentional Radiator per Part 15, Subpart C, paragraphs 15.207, 15.209 and 15.247

And

Innovation, Science, and Economic Development Canada
Certification Per
IC RSS-Gen General Requirements for Radio Apparatus
And
RSS-247 Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices

For the

Acuity Brands Lighting, Inc.

Model Number: 2ADCB-REG127

FCC ID: 2ADCB-REG127
IC: 6715C-REG127

UST Project: 19-0493
Issue Date: January 22, 2020

Total Pages:52

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I certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: Alan Ghasiani

Name: 

Title: Compliance Engineer – President

Date: January 22, 2020

NVLAP LAB CODE 200162-0

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MEASUREMENT TECHNICAL REPORT

COMPANY NAME: Acuity Brands Lighting, Inc.
MODEL: 2ADCB-REG127
FCC ID: 2ADCB-REG127
IC: 6715C-REG127
DATE: January 22, 2020

This report concerns (check one): Original grant [X]
Class II change

Equipment type: IEEE 802.15.4 Radio Module

Report prepared by:

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1 General Information

1.1 Purpose of this Report

This report is prepared as a means of conveying test results and information concerning the suitability of this exact product for full modular approval and public distribution according to IC RSS-247 and FCC Rules and Regulations Part 15, Section 247.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on November 25, 2019 in good operating condition.

1.3 Product Description

The Equipment under Test (EUT) is the Acuity Brands Lighting, Inc, Model: Acuity 2.4 GHz Transmitter Module. The EUT is an IEEE 802.15.4 radio module in a mini PCIe form factor and will primarily be used in streetlight control applications. The EUT rests inside any generic, aftermarket enclosure which will typically be mounted on top of 30’ street lighting, utility poles where the EUT will send and receive data.

1.4 Configuration of Tested System

The Test Sample was tested per *ANSI C63.10:2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices* for the intentional radiator aspect of the device and *ANSI C63.4:2014, Methods of Measurement of Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2014)* for the unintentional radiator aspect of the device as well as FCC subpart B and C of Part 15 and per FCC KDB Publication number 558074 v05r02 for Digital Transmission Systems Operating Under section 15.247.

Digital RF conducted and radiated verification emissions data (FCC 15.107 and 109) below 1 GHz were taken with the measuring receiver (or spectrum analyzer's) resolution bandwidth adjusted to 9 kHz and 120 kHz, respectively. All measurements performed above 1 GHz were made with a RBW of 1 MHz. All measurements are peak unless stated otherwise. The video filter associated with the spectrum analyzer was set to 3 times the RBW or as required per the standard throughout the evaluation process.

A list of EUT and Peripherals is found in Table 1 below. A block diagram of the tested system is shown in Figure 1. Test configuration photographs for spurious and fundamental emissions are provided in separate Appendices.

1.5 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA 30004. This site has been fully described and registered with the FCC. Its designation number is 186022. Additionally, this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1.

1.6 Related Submittal(s)/Grant(s)

The EUT is subject to the following FCC Equipment Authorizations:

a) Certification of the transmitter incorporated within the EUT, see test data presented herein.

b) Verification as a digital device under Part 15 Subpart B.

Table 1. EUT and Peripherals

EUT MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC/IC ID	CABLES P/D
EUT Acuity Brands Lighting, Inc	Acuity 2.4 GHz Module	Engineering Sample	FCC ID: 2ADCB-REG127 IC: 6715C-REG127	P,D,U
PERIPHERAL MANUFACTURER	**MODEL NUMBER**	**SERIAL NUMBER**	**FCC/IC ID**	**CABLES P/D**
Power Adapter Samsung	EP-TA10JWE	SE1F420AS/B-E	N/A	P
Antenna See antenna details	--	--	--	--

S= Shielded, U= Unshielded, P= Power, D= Data

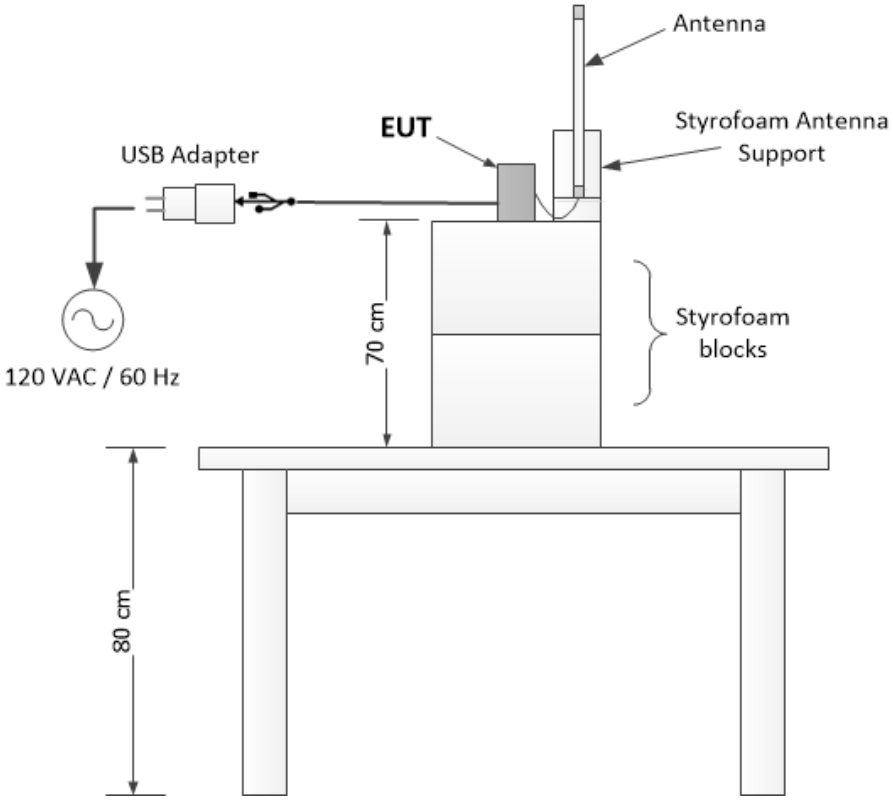


Figure 1. Block Diagram of Test Configuration

2 Tests and Measurements

2.1 Test Equipment

The table below lists test equipment used to evaluate this product.

Table 2. Test Instruments

TEST INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	CALIBRATION DUE DATE
SPECTRUM ANALYZER	E4407B	AGILENT	US41442935	8/17/2020
SPECTRUM ANALYZER	8593	HEWLETT-PACKARD	3205A00124	01/25/2020 extended
RF PREAMP 100 kHz to 1.3 GHz	8447D	HEWLETT-PACKARD	1937A02980	5/7/2020
PREAMP 1.0 GHz to 26.0 GHz	8449B	HEWLETT-PACKARD	3008A00480	4/8/2020
LOOP ANTENNA	SAS-200/562	A. H. Systems	142	1/22/2020 2 yr
BICONICAL ANTENNA	3110B	EMCO	9307-1431	01/23/2020 extended 2 yr
LOG PERIODIC ANTENNA	3146	EMCO	9305-3600	2/1/2021 2 yr
HORN ANTENNA	3115	EMCO	9107-3723	11/28/2020 2 yr
HIGH PASS FILTER	VHF-1320 15542	MICROWAVE CIRCUITS	30843	4/19/2020

Note: The calibration interval of the above test instruments are 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.

2.2 Modifications to EUT Hardware

No modifications were made by US Tech to bring the EUT into compliance with FCC Part 15.247 or IC RSS-210 requirements.

2.3 Number of Measurements for Intentional Radiators (CFR 15.31(m), RSS-Gen 6.8)

Measurements of intentional radiators or receivers shall be performed and reported for each band in which the device can be operated, with the device operating at the number of frequencies in each band specified in Table 3 as follows:

Table 3. Number of Test Frequencies for Intentional Radiators

Frequency Range over which the device operates	Number of Frequencies	Location in the Range of operation
1 MHz or less	1	Middle
1 to 10 MHz	2	1 near the top 1 near the bottom
Greater than 10 MHz	3	1 near top 1 near middle 1 near bottom

Because the EUT operates over 2405 MHz to 2480 MHz, three test frequencies will be used.

2.4 Frequency Range of Radiated Measurements (CFR 15.33, RSS-Gen 6.13)

2.4.1 Intentional Radiator

The spectrum shall be investigated for the intentional radiator from the lowest RF signal generated in the EUT, without going below 9 kHz to the 10th harmonic of the highest fundamental frequency generated or 40 GHz, whichever is the lowest.

2.4.2 Unintentional Radiator

For the digital device, an unintentional radiator, the frequency range shall be 30 MHz to 1000 MHz, or to the range specified in 2.4.1 above, whichever is the higher range of investigation.

2.5 Measurement Detector Function and Bandwidth (CFR 15.35, RSS-Gen 6.9, 6.13)

The radiated and conducted emissions limits shown herein are based on the parameters listed in the following.

2.5.1 Detector Function and Associated Bandwidth

On frequencies below 1000 MHz, the limits herein are based upon measurement equipment employing a CISPR Quasi-peak detector function and related measurement bandwidths (i.e. 9 kHz from 150 kHz to 30 MHz and 120 kHz from 30 MHz to 1000 MHz). Alternatively, measurements may be made with equipment employing a peak detector function as long as the same bandwidths specified for the Quasi-peak device are used.

2.5.2 Corresponding Peak and Average Requirements

Above 1000 MHz, radiated limits are based on measuring instrumentation employing an average detector function. When average radiated emissions are specified there is also a corresponding Peak requirement, as measured using a peak detector, of 20 dB greater than the average limit. For all measurements above 1000 MHz the Resolution Bandwidth shall be at least 1 MHz.

2.5.3 Pulsed Transmitter Averaging

When the radiated emissions limit is expressed as an average value, and the transmitter is pulsed, the measured field strength shall be determined by applying a Duty Cycle Correction Factor based upon dividing the total ON time during the first 100 ms period by 100 ms (or by the period if less than 100 ms). The duty cycle may also be expressed logarithmically in dB. In this case, the Duty Cycle Correction Factor was determined from the manufacturer's claim. This data is presented in paragraph 2.6 and Figure 2 below.

2.6 Transmitter Duty Cycle (Part15.35 (c), RSS-Gen 6.10)

The transmitter is capable of sending three types of transmissions. They are listed below, along with their pulse-width duration:

	Phy. overhead	Data length	TX len	Tx duration (µs)	Warm up (µs)	Sw delay (µs)	Total TX (µs)
Nack	8	15	23	736	144	20	900
ACK	8	24	32	1024	144	20	1188
Msg	8	125	133	4256	144	20	4420

The duty cycle de-rating factor used in the calculation of average radiated limits (per CFR 15.209 and 15.35(c)) is described below. This factor was calculated by first determining the worst case scenario for system operation.

The worst-case scenario in any 125 ms timeslot, along with all transmission lengths, will be as follows:

Transmitter Activity	Duration (µs)
Rcv message	
Send nack	736
Rcv message	
Send nack	736
Rcv message	
Send nack	736
Rcv message	
Send nack	736
Rcv message	
Send nack	736
Send message	4256
Rcv ACK	
Total:	7936

The duty cycle is computed as follows (in any 100 ms period):

Duty Cycle = (7936/100000) = 0.07936 ≈ 0.08 = 8%

Correction Factor = $20\log_{10}(0.08)$ = -21.9 dB

-21.9 dB

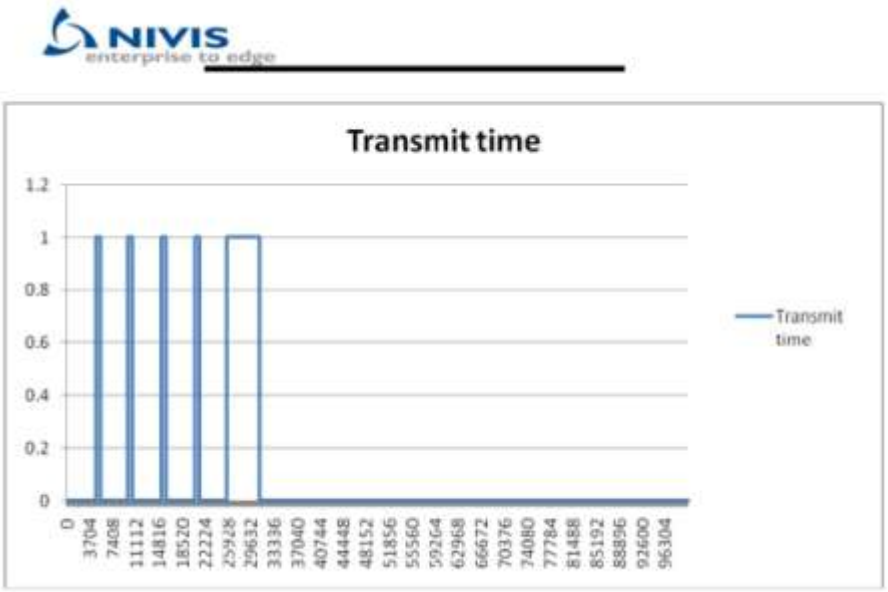


Figure 2. Duty Cycle

2.7 Restricted Bands of Operation (Part 15.205, RSS-Gen 8.10)

Only spurious emissions can fall in the frequency bands of CFR 15.205. The field strength of these emissions cannot exceed the limits of 15.209. Radiated harmonics and other spurious emissions are examined for this requirement see paragraph 2.10.

2.8 EUT Antenna Requirements (CFR 15.203, RSS-Gen 6.7)

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 EUT is designed for use with a Skywave Antennas® fiberglass antenna, Model:11-1087-A and has a recessed N-type connector. The antenna gain is 6 dBi.

Manufacturer	Model	Type/Gain (dBi)	Connector
Skywave	11-1087-A	Dipole/+6.0	N-type to SMA

2.9 Maximum Peak Conducted Output Power (CFR 15.247(b)(3), RSS-247 (5.4(d)))

The EUT was programmed to operate at a normal operating output power across the bandwidth. For this test the normal operating output power of the radio was programmed to level 7 in the radio's test firmware.

Peak power within the band 2405 MHz to 2480 MHz was measured per FCC KDB Publication 558074v05r02. Antenna-port RF conducted output power test was performed.

Table 4. Peak Antenna Conducted Output Power per Part 15.247 (b)(3)

Frequency of Fundamental (MHz)	P_{Cond}	(mW)	FCC Limit (mW Maximum)
2405	18.57	71.945	1000
2440	18.94	78.343	1000
2480	17.13	51.642	1000

Test Date: November 27, 2019

Tested By
Signature:  Name: Mark Afroozi

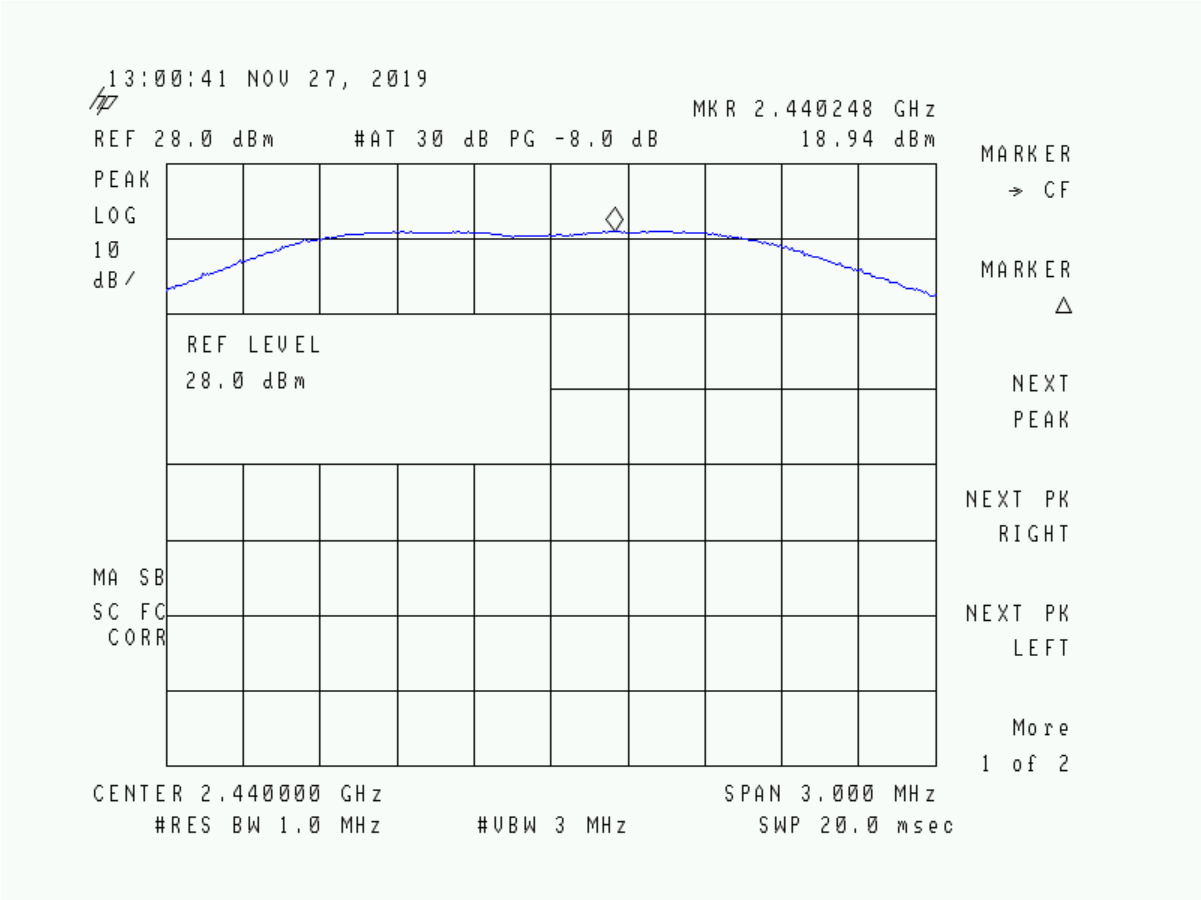


Figure 3. Maximum Measured Output Power

2.10 Power Spectral Density (CFR 15.247(e), RSS-247 (5.2(b)))

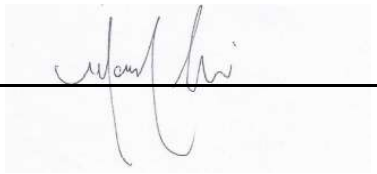
For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. The same method of determining the conducted output power shall be used to determine the power spectral density.

If the measured peak conducted output power complies with the regulatory requirement for PSD, then measurement of PSD is not required. Since the measured conducted output power of the EUT exceeds +8 dBm, PSD measurements were made. The results are presented in the table below.

Table 5. Peak Power Spectral Density

Frequency of Fundamental (MHz)	PSD (dBm @ 3 kHz)	FCC Limit (dBm @ 3 kHz)	Margin
2405	+3.58	+8.0	4.42
2440	+3.67	+8.0	4.33
2480	+1.93	+8.0	6.07

Test Date: November 27, 2019

Tested By
Signature:  Name: Mark Afroozi

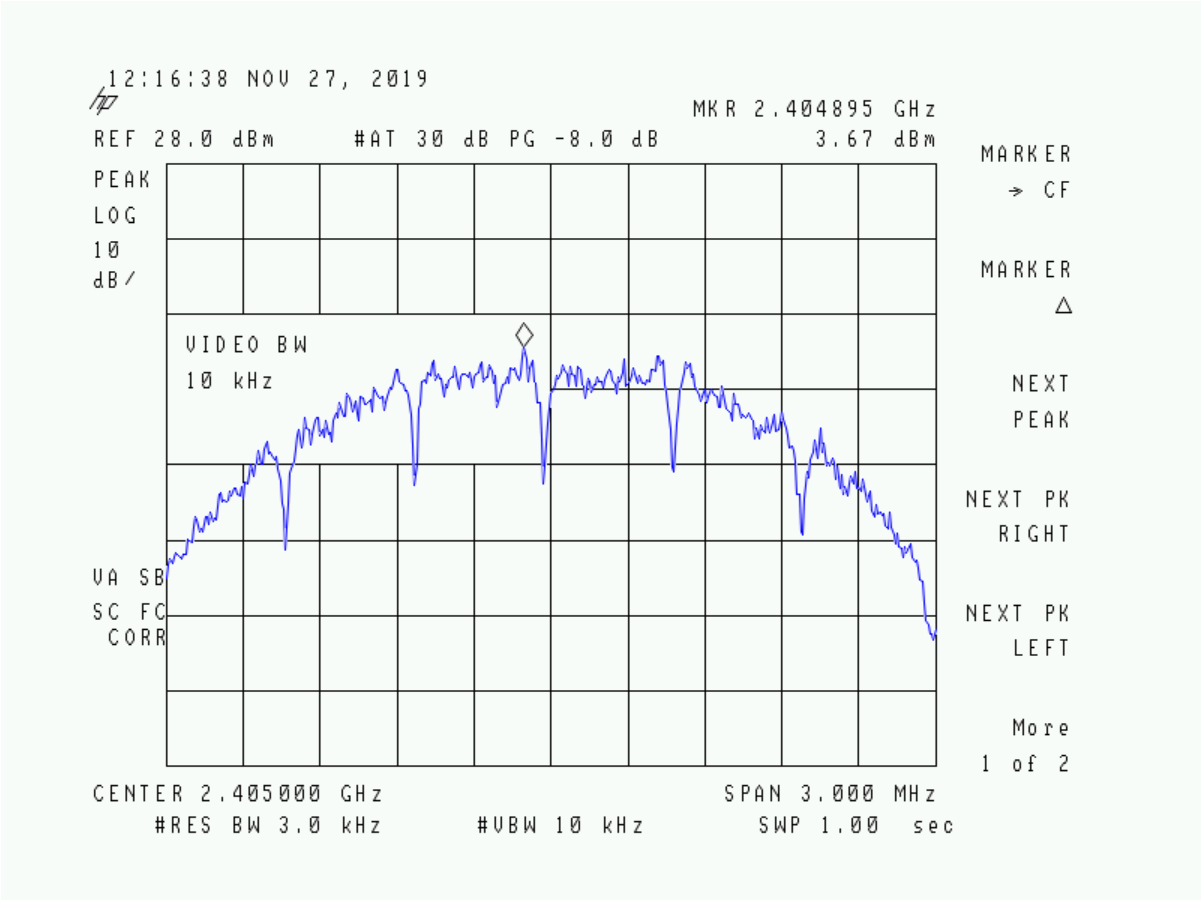


Figure 4. Maximum Measured PSD

2.11 Antenna Conducted Intentional and Spurious Emissions (CFR 15.209, 15.247(d)) (RSS-247 (5.5), RSS-Gen 8.9)

The EUT was put into a continuous-transmit mode of operation and tested per FCC KDB Publication 558074v05r02 for conducted out of band emissions radiating from the antenna port over the frequency range of 30 MHz to ten times the highest clock frequency generated or used in this case, 25 GHz. A conducted scan was performed on the EUT to identify and record spurious signals that were related to the transmitter. Antenna conducted emissions of a significant magnitude that fell within restricted bands were then measured as radiated emissions in the semi-anechoic chamber. The conducted emissions graphs are found in figures below. All spurious emissions must be at least 20 dB below the fundamental signal.

For RF antenna conducted tests, the RBW was set to 1 MHz, video bandwidth (VBW)> RBW, scan up through the 10^{th} harmonic of the fundamental frequency. All harmonics/spurs must be at least 20 dB down from the highest emission level within the authorized band.

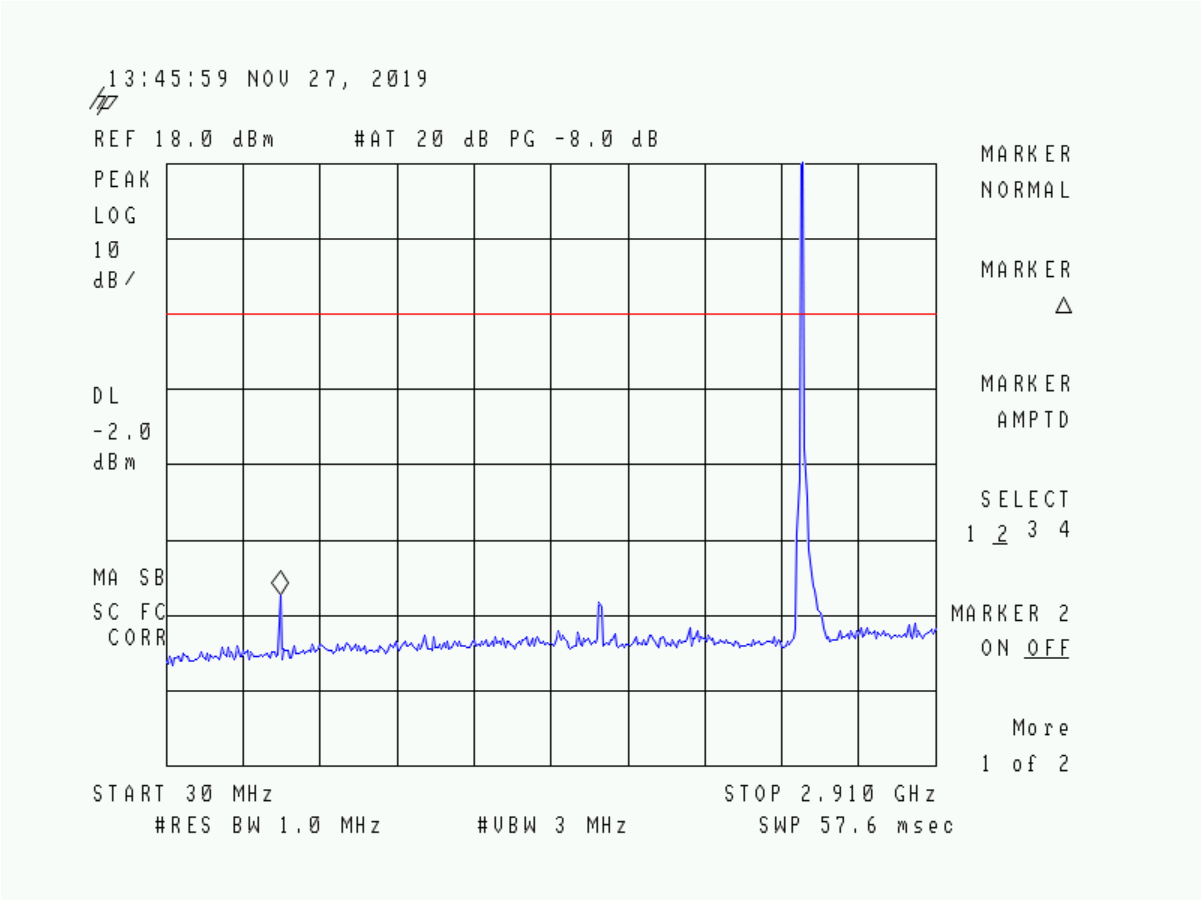


Figure 5. Conducted Spurious Emissions – Low Channel, 30 MHz – 2.91 GHz

Large Signal shown is fundamental frequency.
Display line represents 20 dB below peak of fundamental frequency.

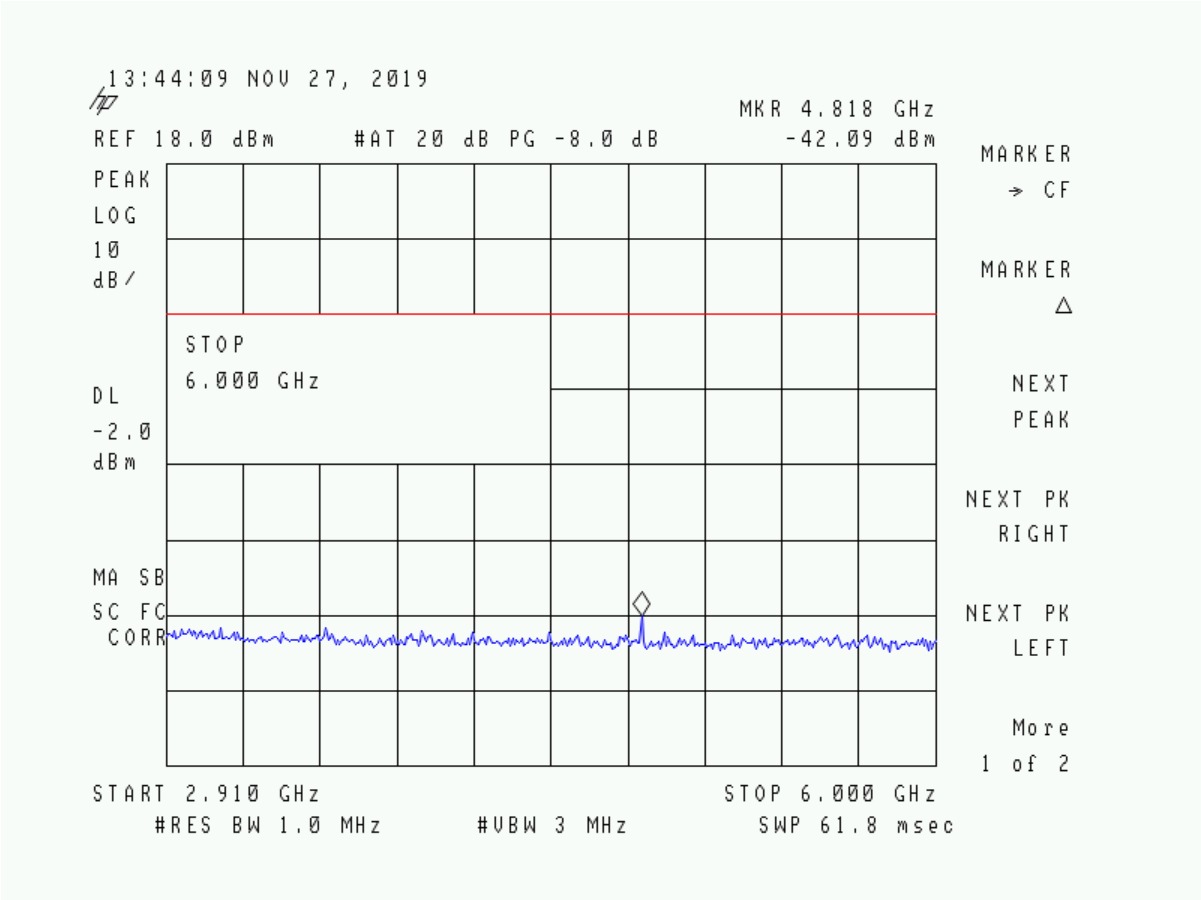


Figure 6. Conducted Spurious Emissions – Low Channel, 2.91 GHz – 6 GHz

Display line represents 20 dB below peak of fundamental frequency

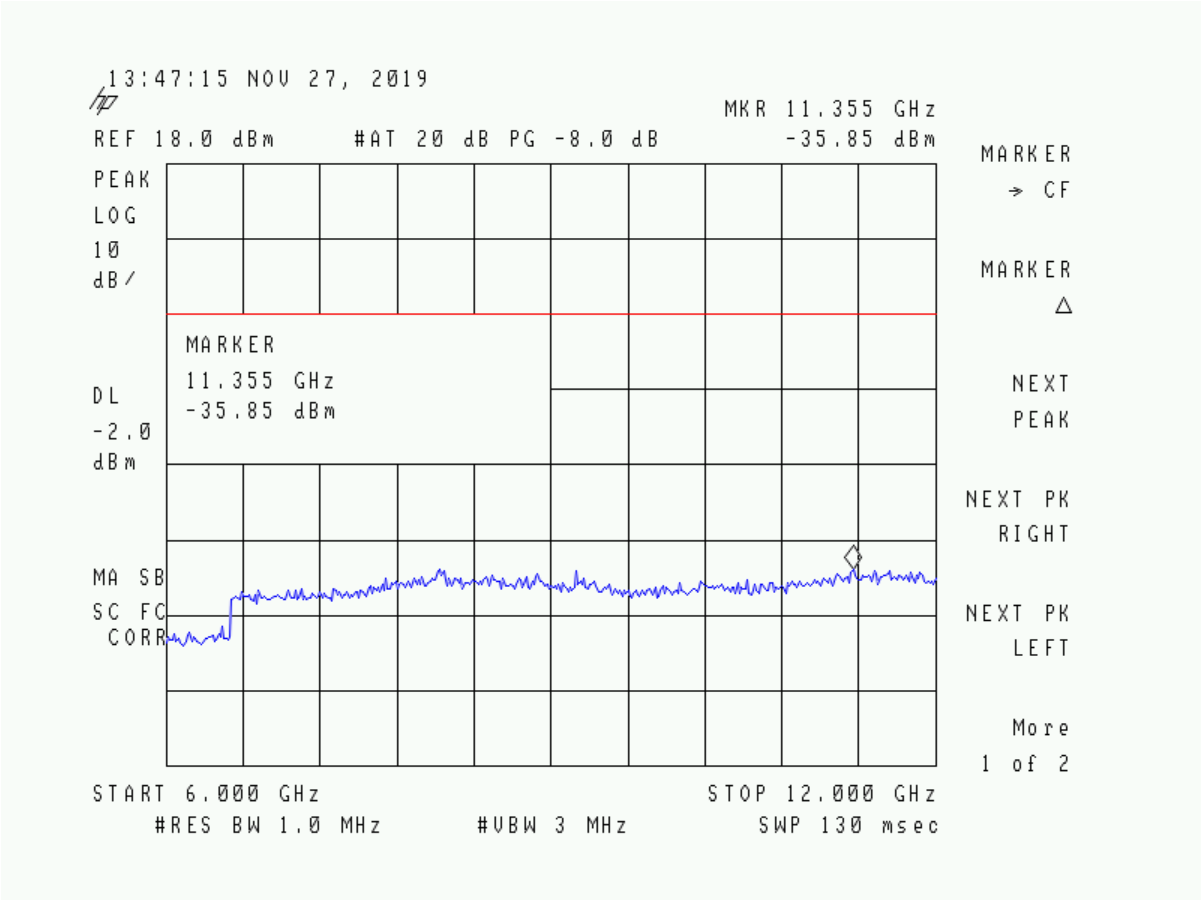


Figure 7. Conducted Spurious Emissions – Low Channel, 6 GHz - 12 GHz

Display line represents 20 dB below peak of fundamental frequency.

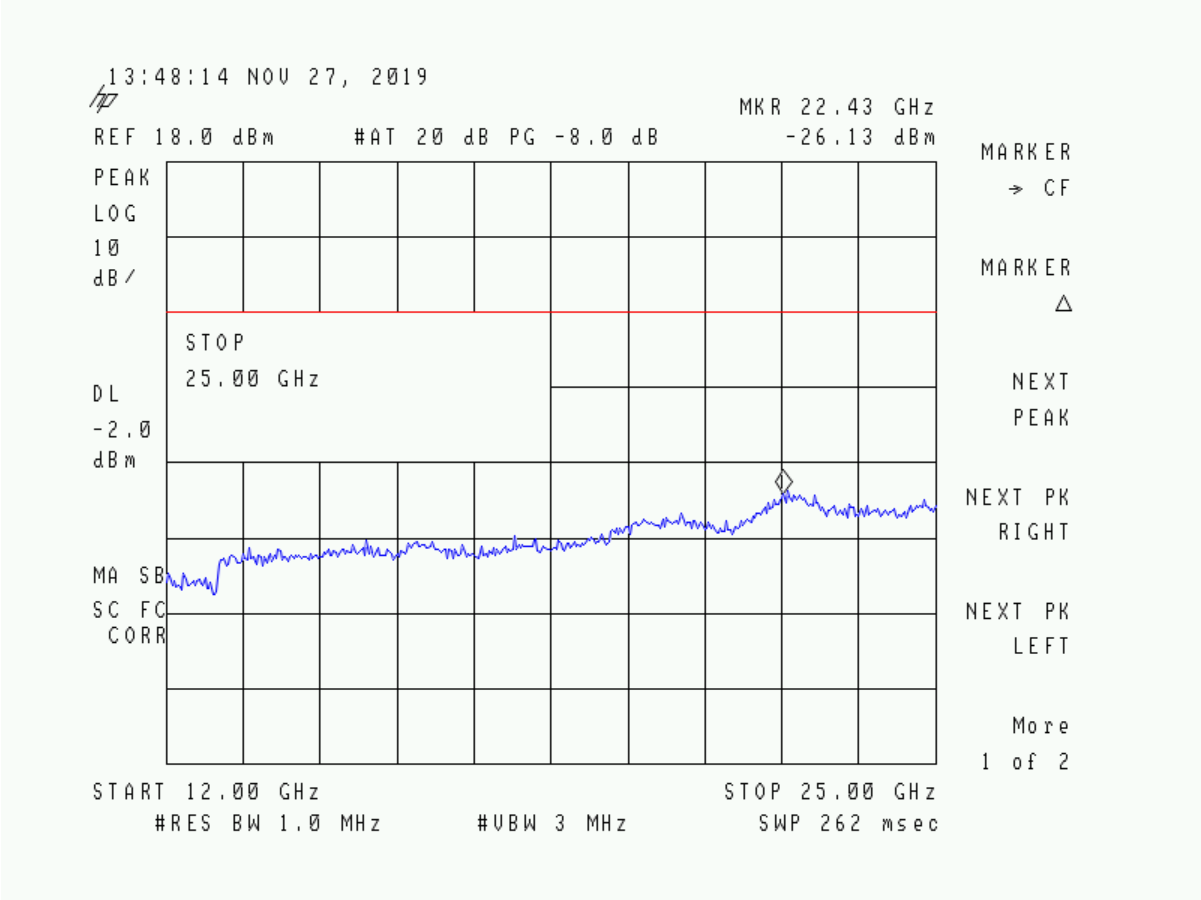


Figure 8. Conducted Spurious Emissions – Low Channel, 12 GHz – 25 GHz

Display line represents 20 dB below peak of fundamental frequency

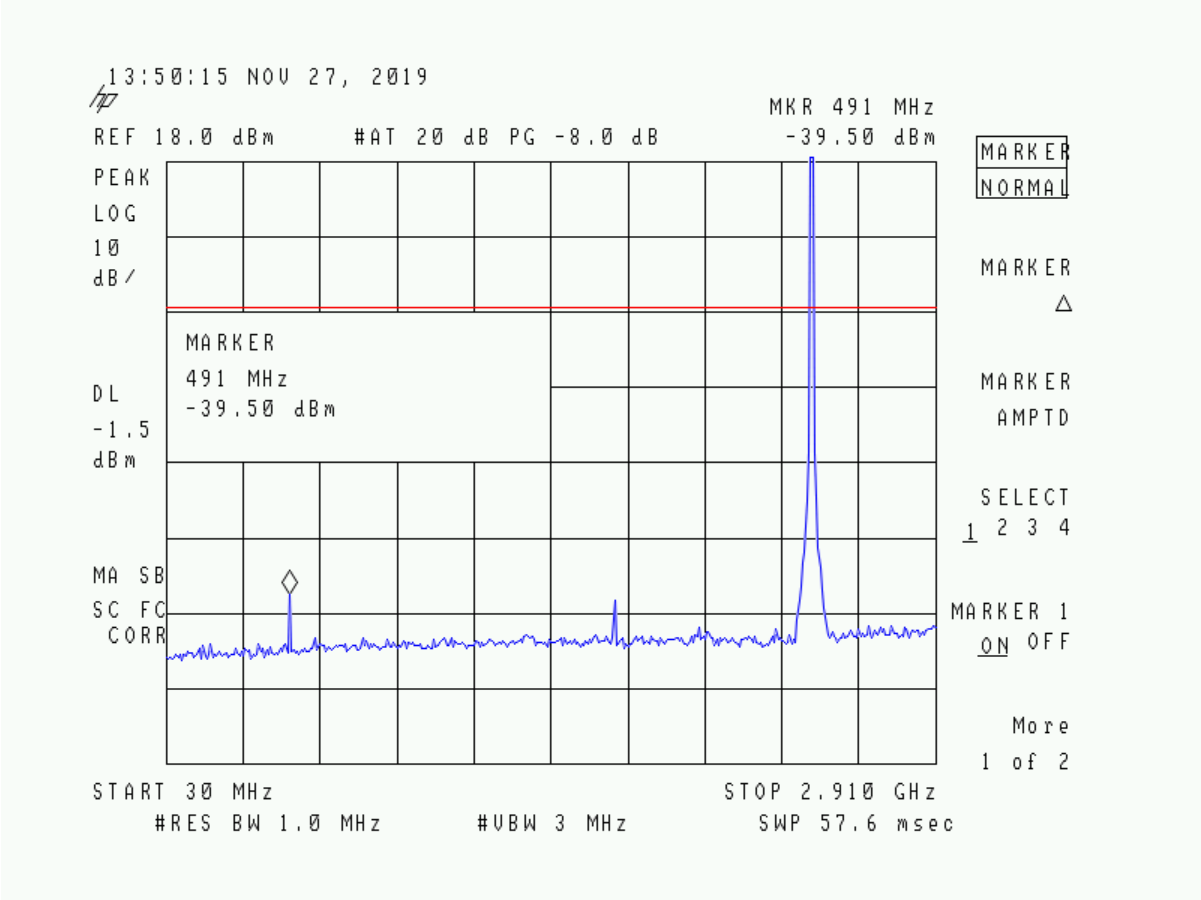


Figure 9. Conducted Spurious Emissions – Mid Channel, 30 MHz – 2.91 GHz

Large Signal shown is fundamental frequency.
Display line represents 20 dB below peak of fundamental frequency.

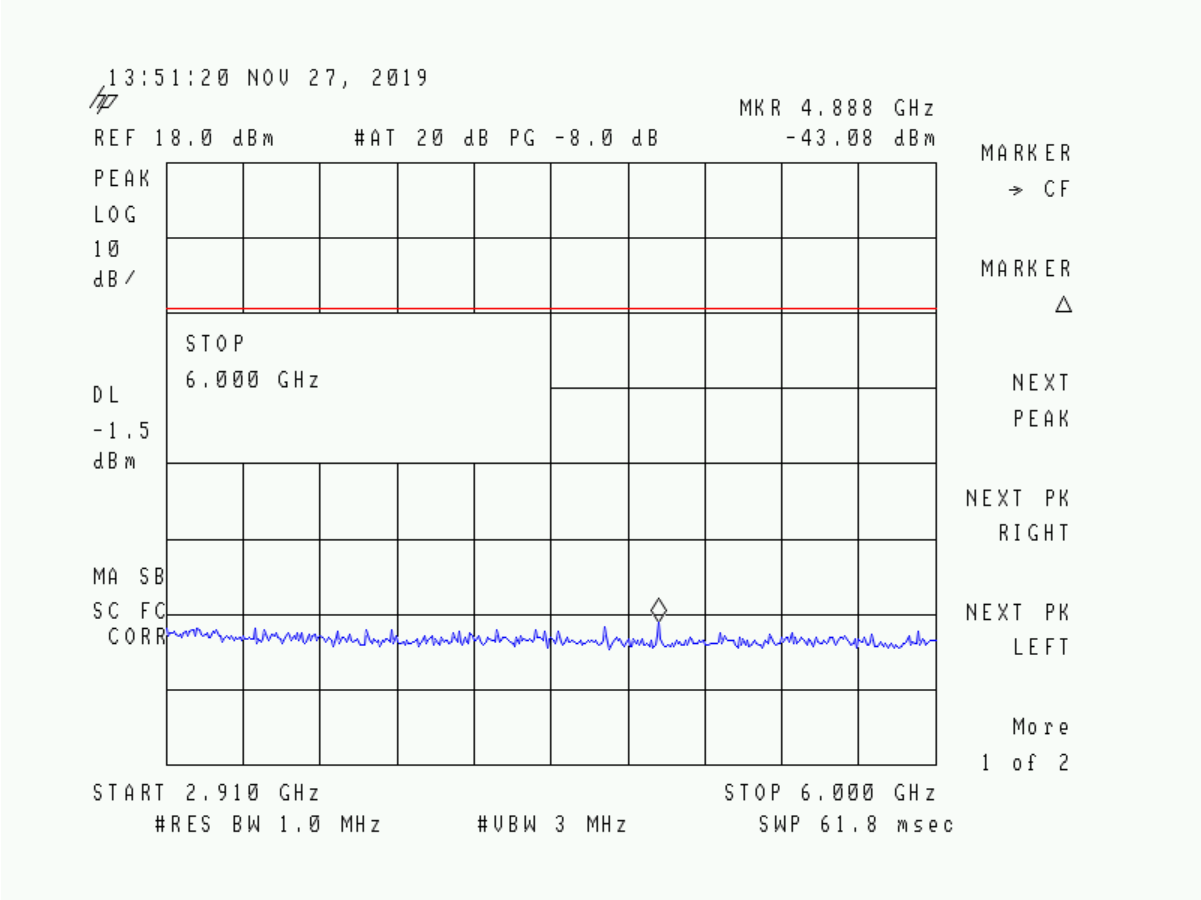


Figure 10. Conducted Spurious Emissions – Mid Channel, 2.91 GHz – 6 GHz

Display line represents 20 dB below peak of fundamental frequency.

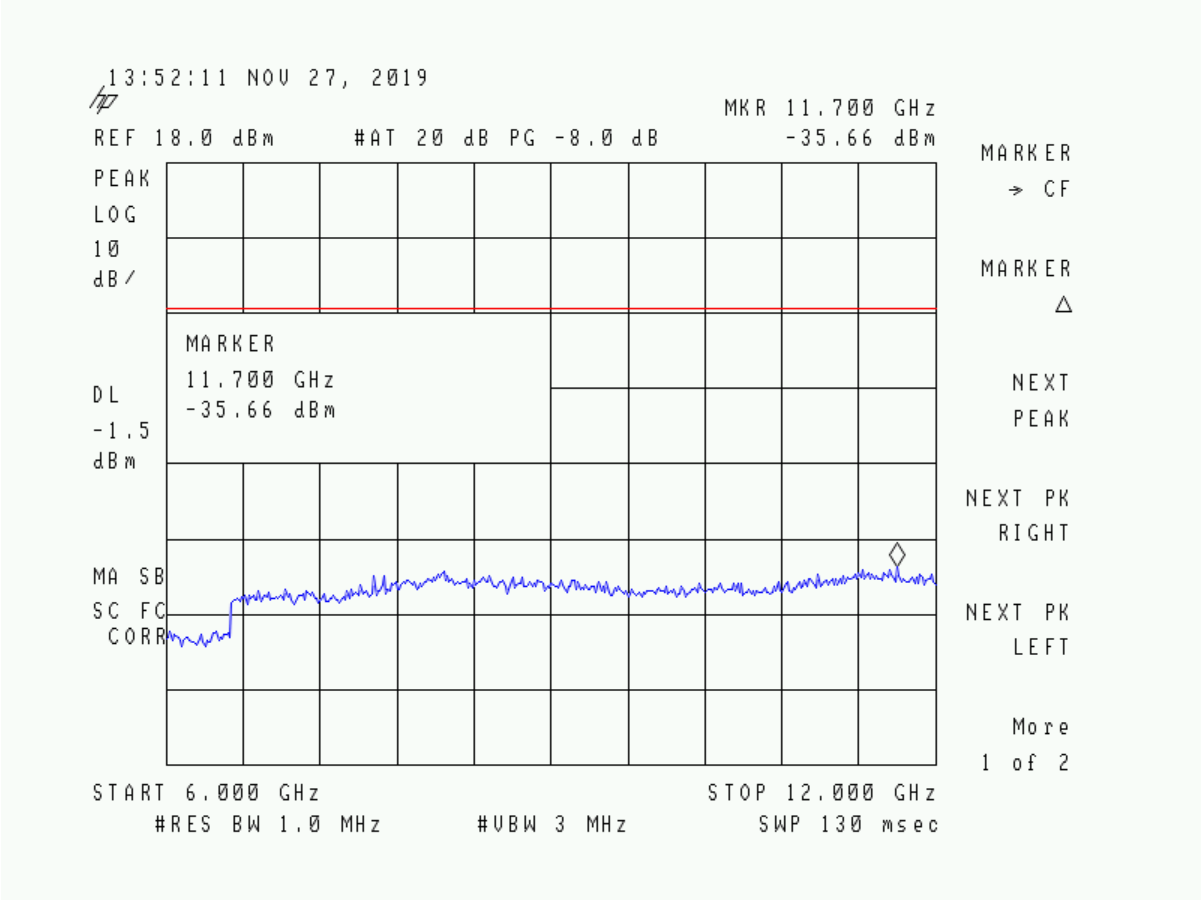


Figure 11. Conducted Spurious Emissions – Mid Channel, 6 GHz – 12 GHz

Display line represents 20 dB below peak of fundamental frequency.

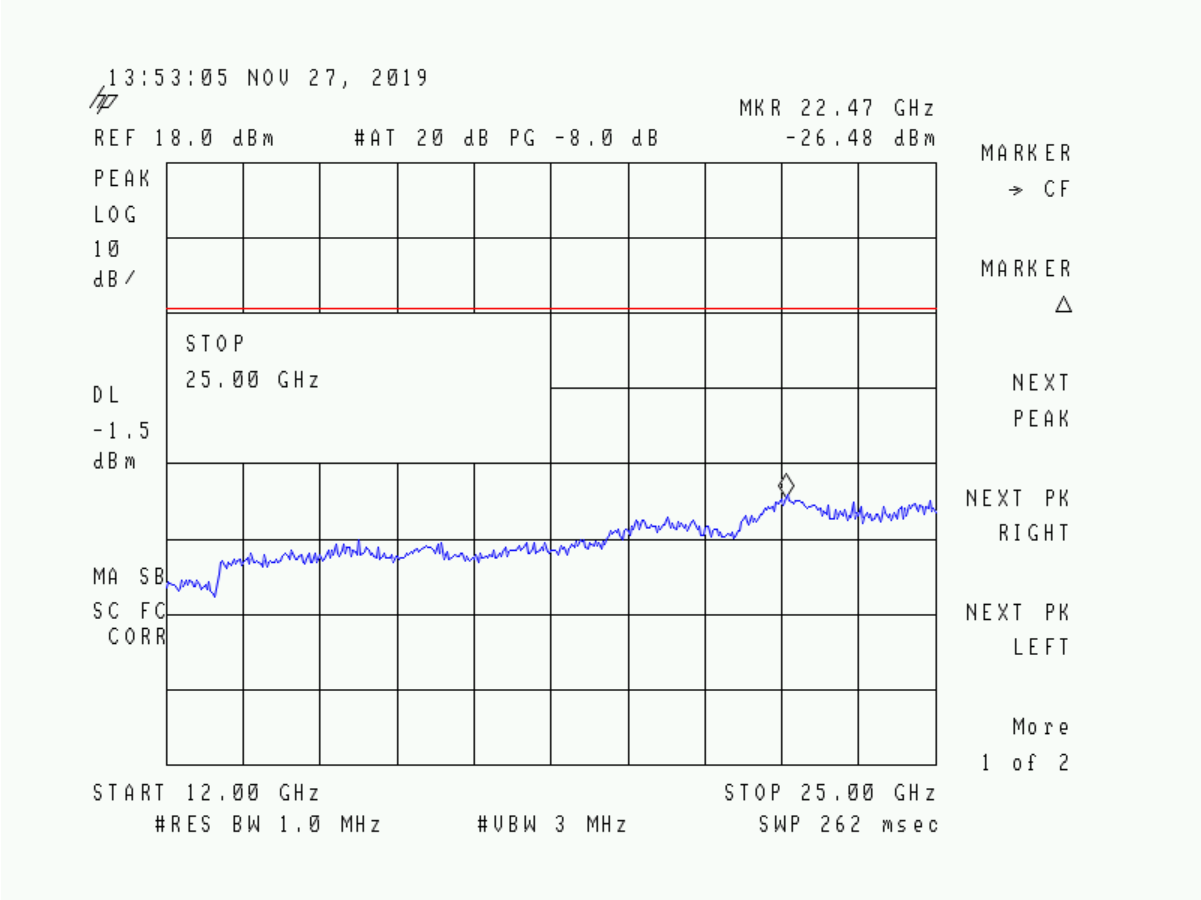


Figure 12. Conducted Spurious Emissions – Mid Channel, 12 GHz – 25 GHz

Display line represents 20 dB below peak of fundamental frequency.

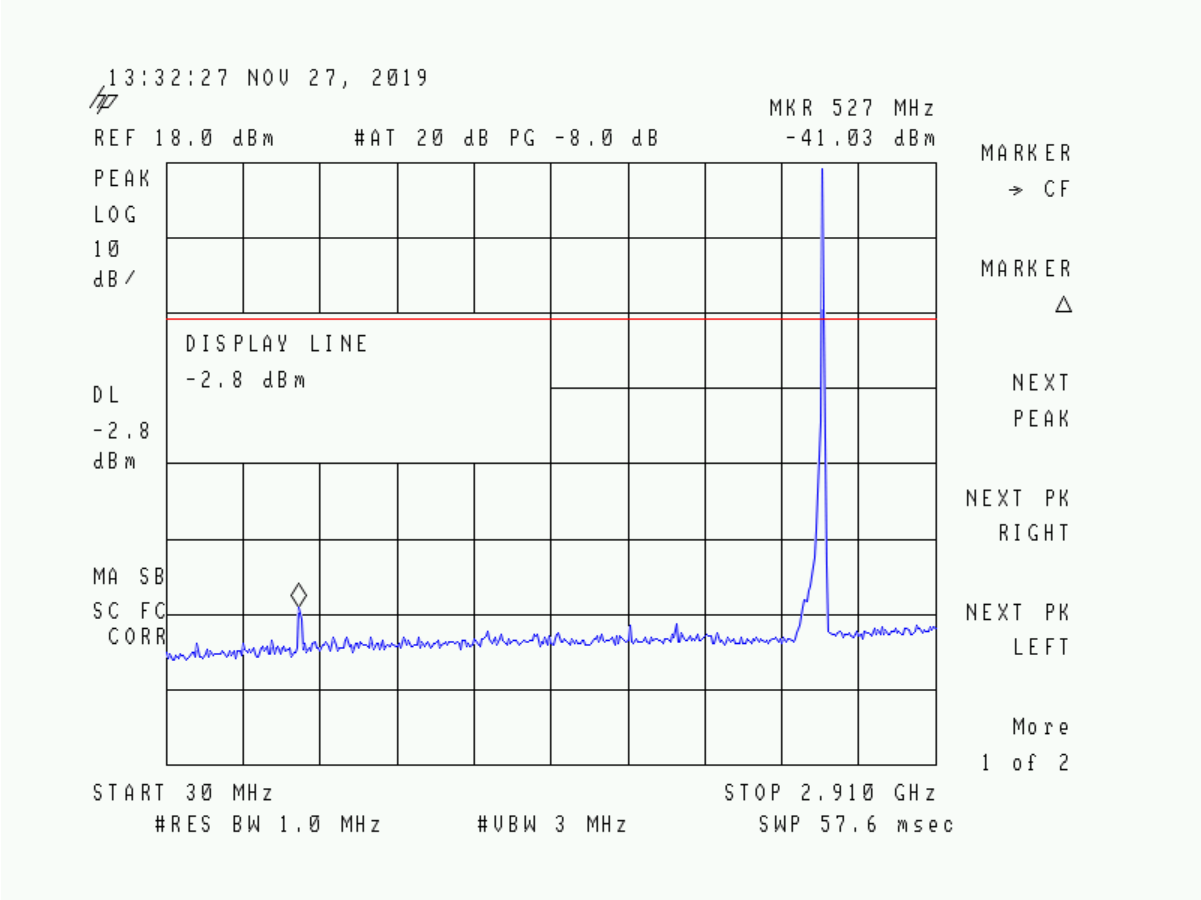


Figure 13. Conducted Spurious Emissions – High Channel, 30 MHz - 2.91 GHz

Large Signal shown is fundamental frequency.
Display line represents 20 dB below peak of fundamental frequency.

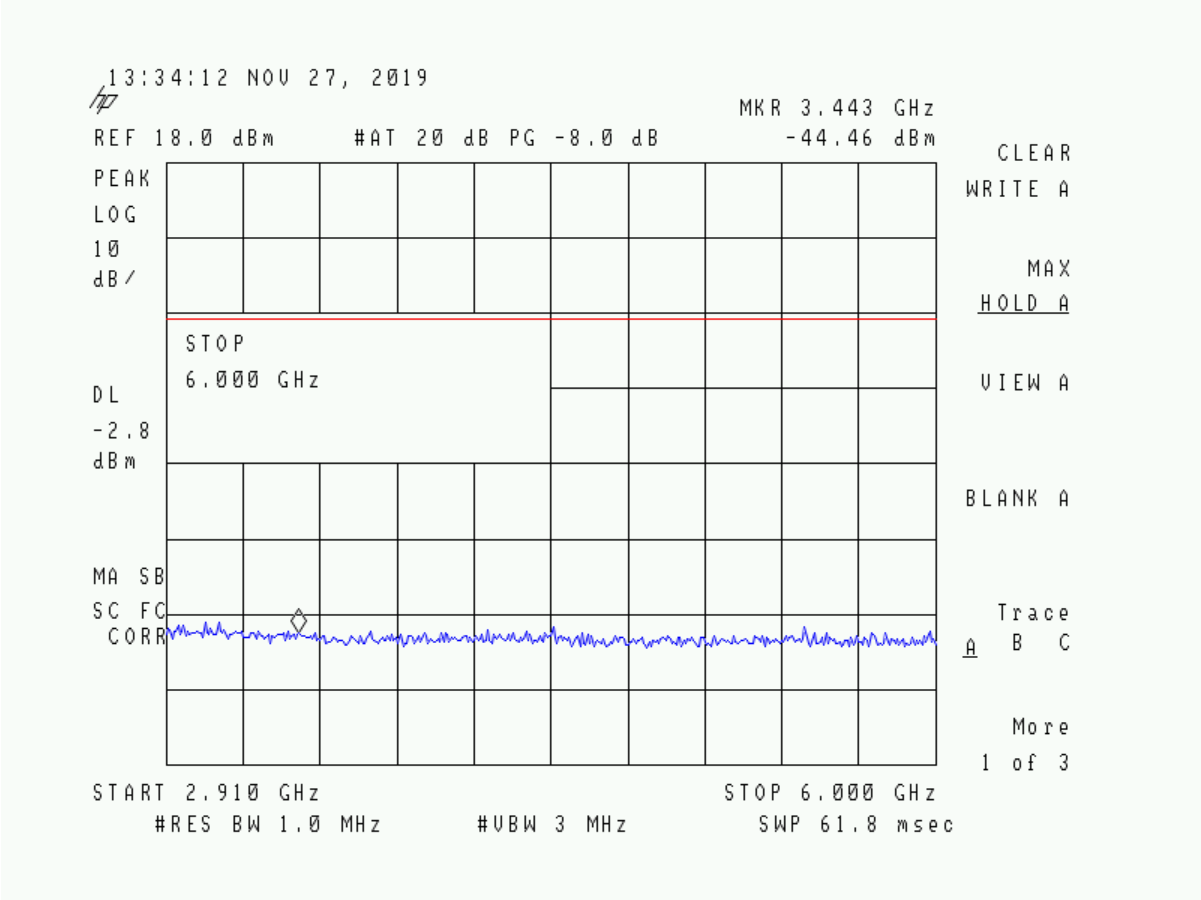


Figure 14. Conducted Spurious Emissions – High Channel, 2.91 GHz – 6 GHz

Display line represents 20 dB below peak of fundamental frequency.

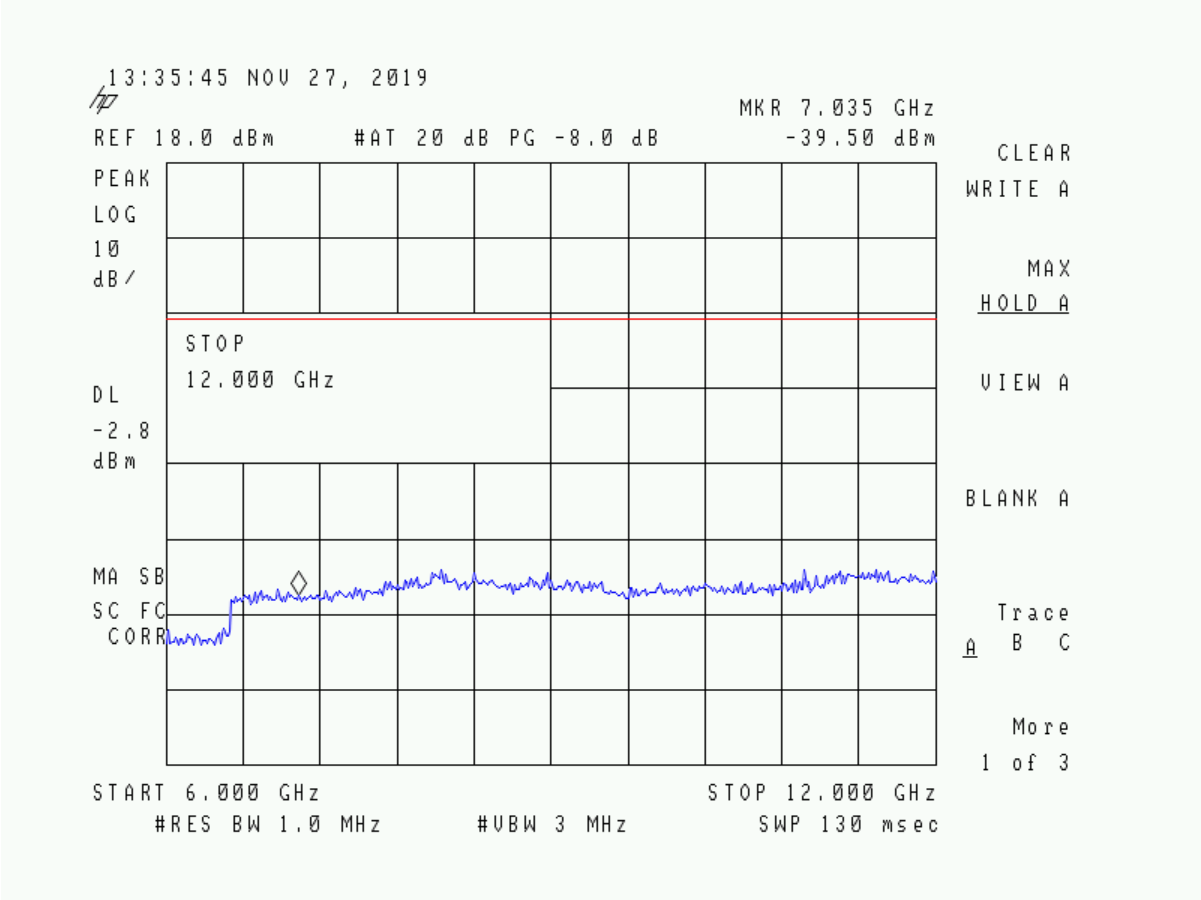


Figure 15. Conducted Spurious Emissions – High Channel, 6 GHz – 12 GHz

Display line represents 20 dB below peak of fundamental frequency.

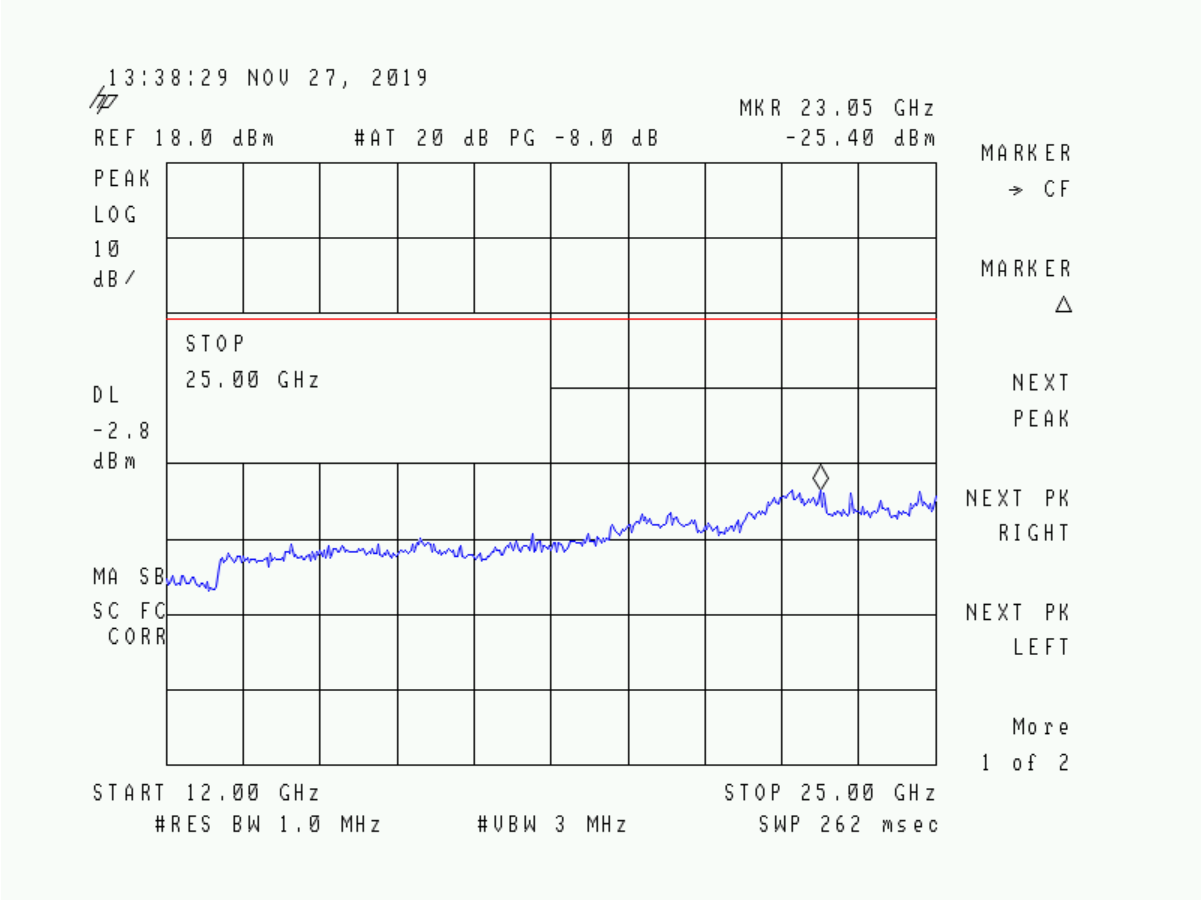


Figure 16. Conducted Spurious Emissions – High Channel, 12 GHz – 25 GHz

Display line represents 20 dB below peak of fundamental frequency.

2.12 Intentional Radiator, Radiated Emissions (CFR 15.209, 15.247(d), RSS-247 (5.2),(5.5))

On the test site, the EUT was mounted on top of a non-conductive table, 80 cm above the floor, by placing it in the X-Z plane along the Z axis with its bottom cover in parallel with the ground. The front of the EUT faced the measurement antenna located 3 meters away. Each signal measured was maximized by raising and lowering the receive antenna between 1 and 4 meters in height while monitoring the ever changing spectrum analyzer display (with channel A in the Clear-Write mode and channel B in the Max-Hold mode) for the largest signal visible. That exact antenna height where the signal was maximized was recorded for reproducibility purposes. Also, the EUT was rotated about its Y-axis while monitoring the Spectrum Analyzer display for maximum. The EUT azimuth was recorded for reproducibility purposes. The EUT was measured when both maxima were simultaneously satisfied.

For radiated measurements, the EUT was set into a continuous transmission mode. Below 1 GHz, the RBW of the measuring instrument was set equal to 120 kHz. Peak measurements above 1 GHz were measured using a RBW = 1 MHz, with a VBW ≥ 3 x RBW. The results of peak radiated spurious emissions falling within restricted bands are given in Table 5 below. For average measurements above 1 GHz, the emissions were measured using an average detector.

Table 6. Peak Radiated Fundamental, Harmonic Emissions & Restricted Band Edges

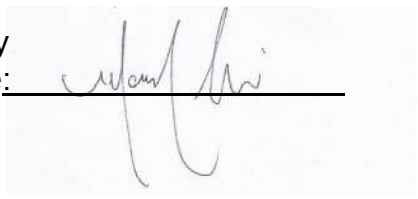
Tested By: MA	Test: FCC Part 15,247(d)				Client: Acuity Brands Lighting, Inc			
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factor**	**AF+CL-PA (dB/m)**	**Corrected Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector**
Low Channel								
2405	94.86	--	32.28	127.14	--	3.0m./VERT	--	**PK**
4810	54.97	--	7.72	62.69	74.0	3.0m./VERT	11.3	**PK**
See note 1								
Middle Channel								
2440	93.78	--	32.28	126.06	--	3.0m./VERT	--	**PK**
4880	49.57	--	5.93	55.50	74.0	3.0m./VERT	18.5	**PK**
7320	44.40	--	17.68	62.08	74.0	1.0m./VERT	11.9	**PK**
See note 1								
High Channel								
2480	86.18	--	31.47	117.65	--	3.0m./VERT	--	**PK**
4960	51.13	--	8.52	59.65	74.0	3.0m./HORZ	14.4	**PK**
See note 1								
Restricted Band Edges								
2389.58	39.28		32.60	71.88	74.0	3.0m./VERT	2.1	**PK**
2483.95	39.93	--	31.47	71.40	74.0	3.0m./VERT	2.6	**PK**

1. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic

Sample Calculation at 2405 MHz:

Magnitude of Measured Frequency	94.86	dBuV
+Additional Factor	0.00	dB
+Antenna Factor + Cable Loss - Amplifier Gain	32.28	dB/m
Corrected Result	127.14	dBuV/m

Test Date: November 25, 2019

Tested By
Signature: 

Name: Mark Afroozi

Table 7. Average Radiated Fundamental, Harmonic Emissions & Restricted Band Edges

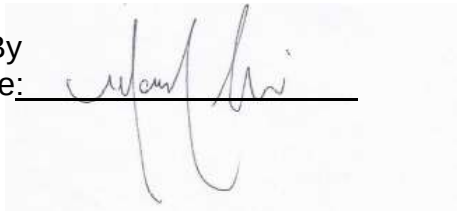
Tested By: MA	Test: FCC Part 15,247(d)			Client: Acuity Brands Lighting, Inc				
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factor**	**AF+CL-PA (dB/m)**	**Corrected Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector**
Low Channel								
2405	94.59	--	32.28	126.87	--	3.0m./VERT	--	**AVG**
4810	45.45	-21.90	7.72	31.27	54.0	3.0m./VERT	22.7	**AVG**
See note 1								
Middle Channel								
2440	91.67	--	32.28	123.95	--	3.0m./VERT	--	**AVG**
4880	37.64	--	5.93	43.57	54.0	3.0m./VERT	10.4	**AVG**
7320	30.65	--	17.68	48.33	54.0	1.0m./VERT	5.7	**AVG**
See note 1								
High Channel								
2480	83.73	--	31.47	115.20	--	3.0m./VERT	--	**AVG**
4960	38.50	--	8.52	47.02	54.0	3.0m./HORZ	7.0	**AVG**
See note 1								
Restricted Band Edges								
2389.58	29.14	-21.90	32.60	39.84	54.0	3.0m./VERT	14.2	**AVG**
2483.95	28.28	-21.90	31.47	37.85	54.0	3.0m./VERT	16.2	**AVG**

1. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
2. A duty cycle correction factor of -21.9 was applied to average measurements exceeding limits.

Sample Calculation at 4810 MHz:

Magnitude of Measured Frequency	45.45	dBuV
+Additional Factor (Duty cycle correction)	-21.90	dB
+Antenna Factor + Cable Loss - Amplifier Gain	7.72	dB/m
Corrected Result	31.27	dBuV/m

Test Date: November 25, 2019

Tested By
Signature:  Name: Mark Afroozi

2.13 Band Edge Measurements – (CFR 15.247(d), RSS-Gen 8.10)

Band Edge measurements are made following the guidelines in FCC KDB Publication No. 558074 v05r02 with the EUT initially operating on the Lowest Channel and then operating on the Highest Channel within its band of operation. Antenna port conducted measurements are performed to demonstrate compliance with the requirement of 15.247(d) that all emissions outside of the band edges be attenuated by at least 20 dB when compared to its highest in-band value (contained in a 100 kHz band).

To capture the band edge set the Spectrum Analyzer frequency span large enough (usually around 10 MHz) to capture the peak level of the emission operating on the channel closest to the band edge as well as any modulation products falling outside of the authorized band of operation. Conducted measurements are performed with RBW ≥1% of the frequency span. In all cases, the VBW is set ≥3 x RBW. See figures and calculations below for more detail.

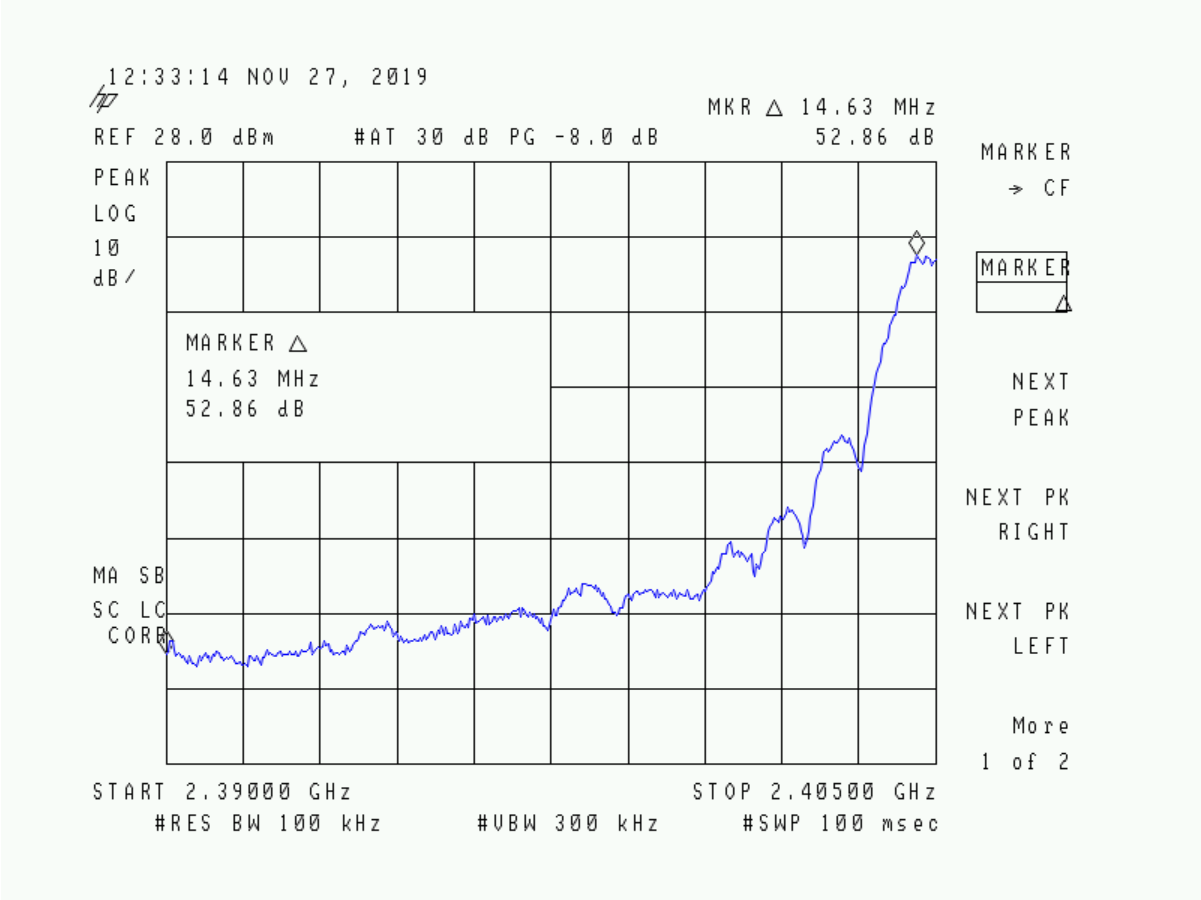


Figure 17. Band Edge Compliance – Low Channel Delta - Peak

Lower band edge must be 20 dB below the fundamental. This requirement is met.

Measured Result	52.86	dB
Band Edge Limit	20.00	dB
Band Edge Margin	32.86	dB

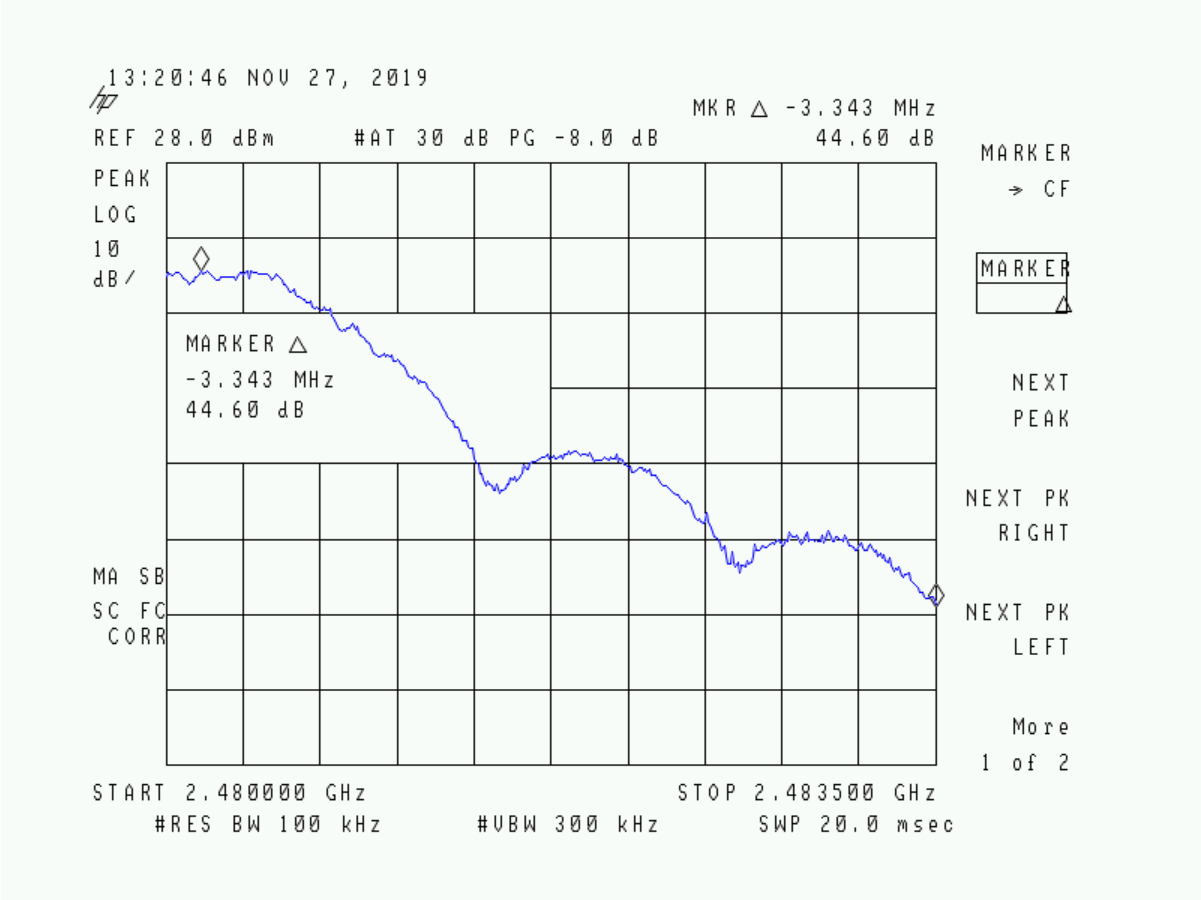


Figure 18. Band Edge Compliance – High Channel Delta - Peak

Higher band edge must be 20 dB below the fundamental. This requirement is met.

Measured Result	44.60	dB
Band Edge Limit	20.00	dB
Band Edge Margin	24.60	dB

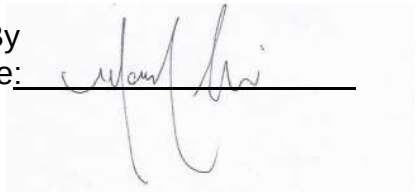
2.14 Six (6) dB Bandwidth (CFR 15.247(a)(2), RSS-247 (5.2(a)))

The EUT antenna port was connected to a spectrum analyzer having a 50 Ω input impedance. Measurements were performed similar to the method of FCC, KDB Publication No. 558074 v05r02 for a bandwidth of 6 dB. The RBW was set to approximately 1/100 of the manufacturers claimed RBW and with the VBW ≥ RBW. The results of this test are given in the table below and figures below.

Table 8. Six (6) dB Bandwidth

Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum FCC Bandwidth (MHz)
2405	1.60	0.5
2440	1.65	0.5
2480	1.55	0.5

Test Date: November 27, 2019

Tested By
Signature:  Name: Mark Afroozi

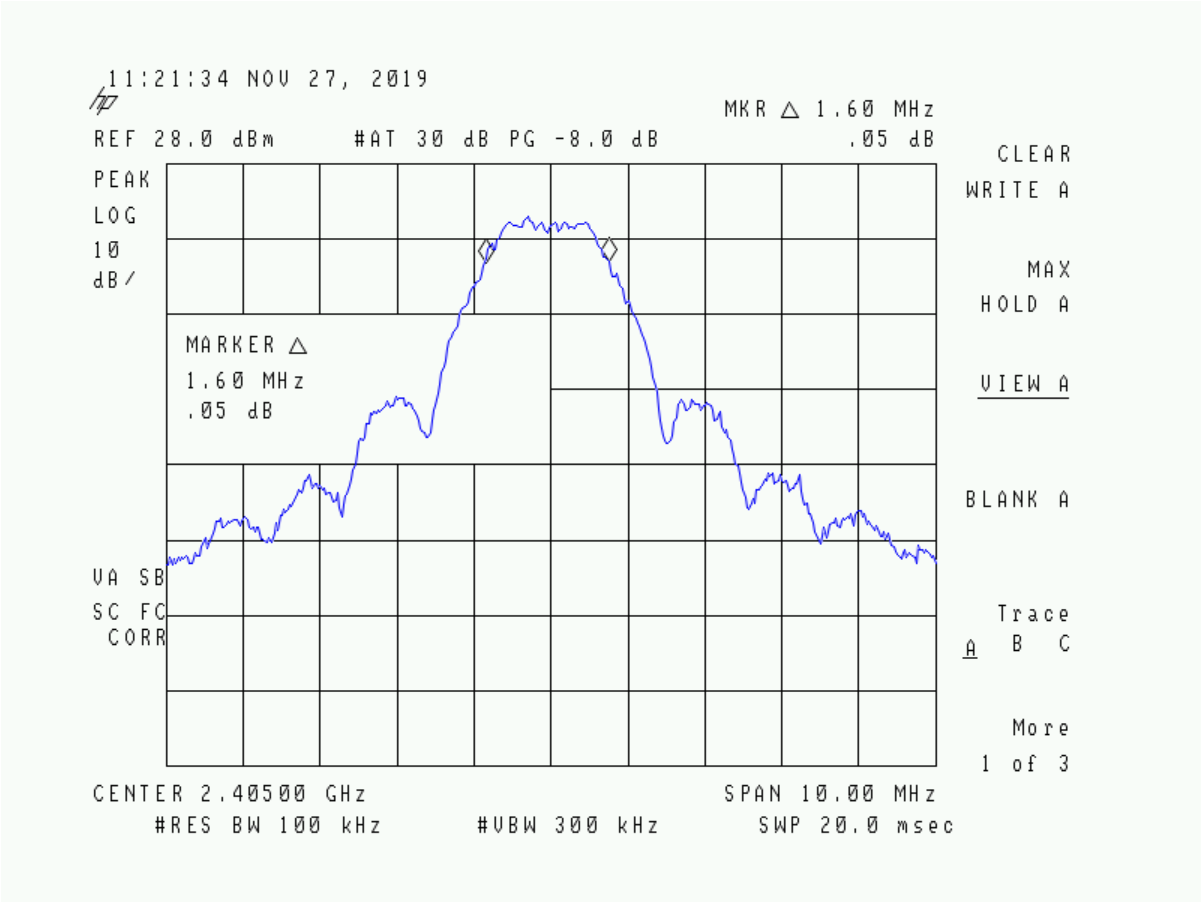


Figure 19. 6 dB Bandwidth Low Channel

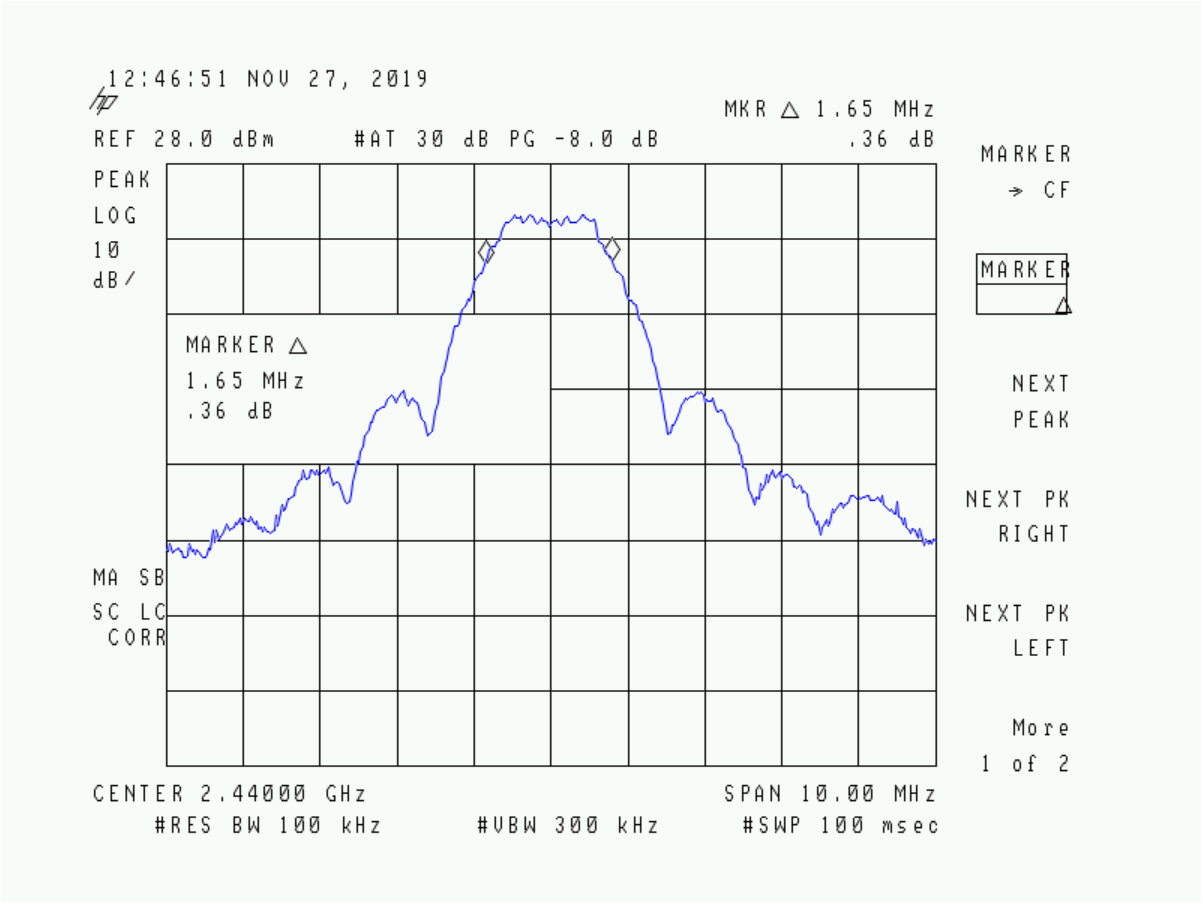


Figure 20. 6 dB Bandwidth Mid Channel

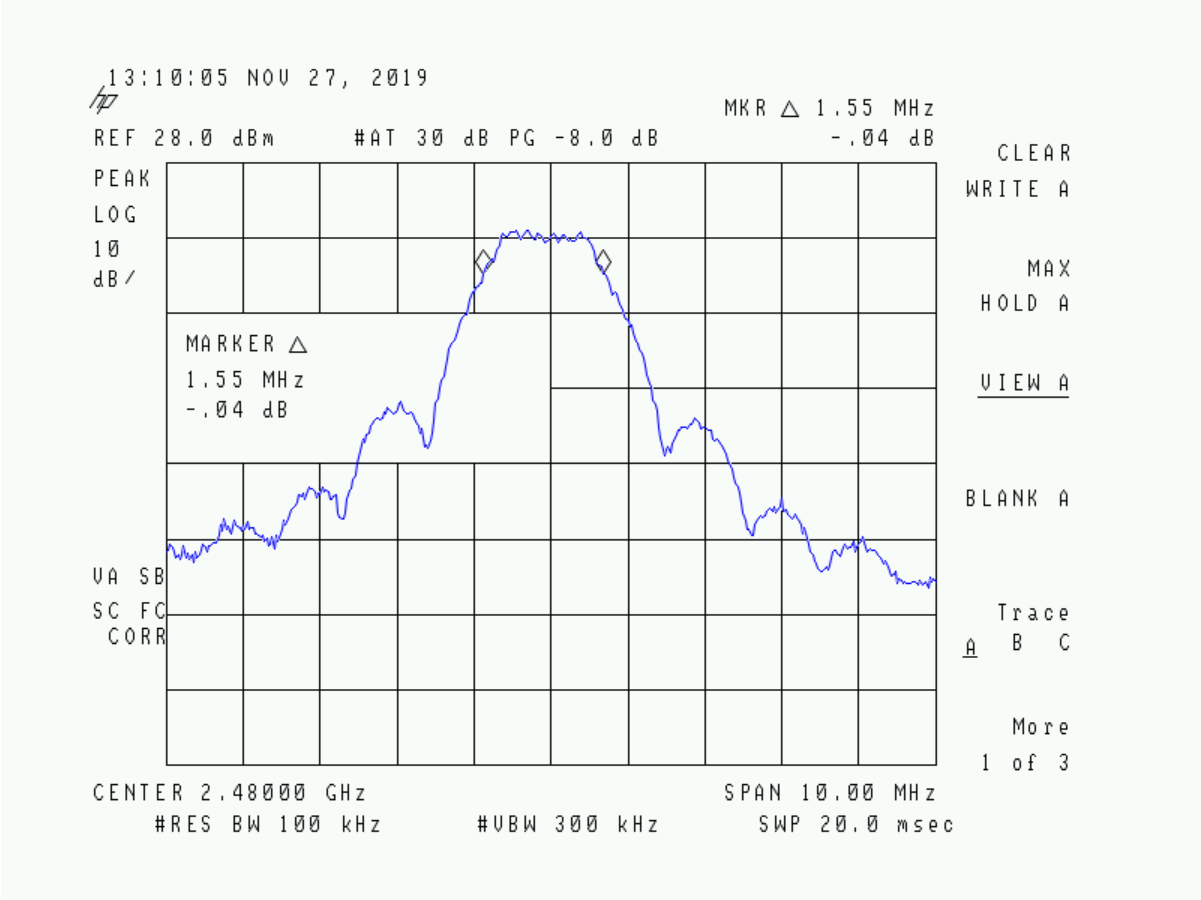


Figure 21. 6 dB Bandwidth High Channel

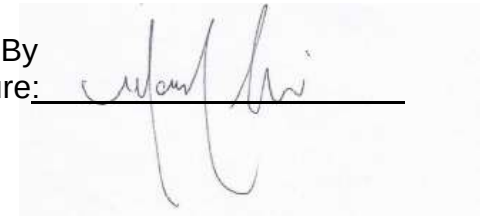
2.15 99% Occupied Bandwidth (RSS-GEN (6.6))

The EUT antenna port was connected to a spectrum analyzer having a 50Ω input impedance. Measurements were performed similar to the method of FCC, KDB Publication No. 558074 v05r02 for a bandwidth of 20 dB. The RBW was set to approximately 1/100 of the manufacturers claimed RBW and with the VBW ≥ RBW. The results of this test are given in the table below and figures below.

Table 9. 99% Occupied Bandwidth

Frequency (MHz)	(99%) Occupied Bandwidth (MHz)
2405	2.370
2440	2.370
2480	2.355

Test Date: November 27, 2019

Tested By
Signature:  Name: Mark Afroozi

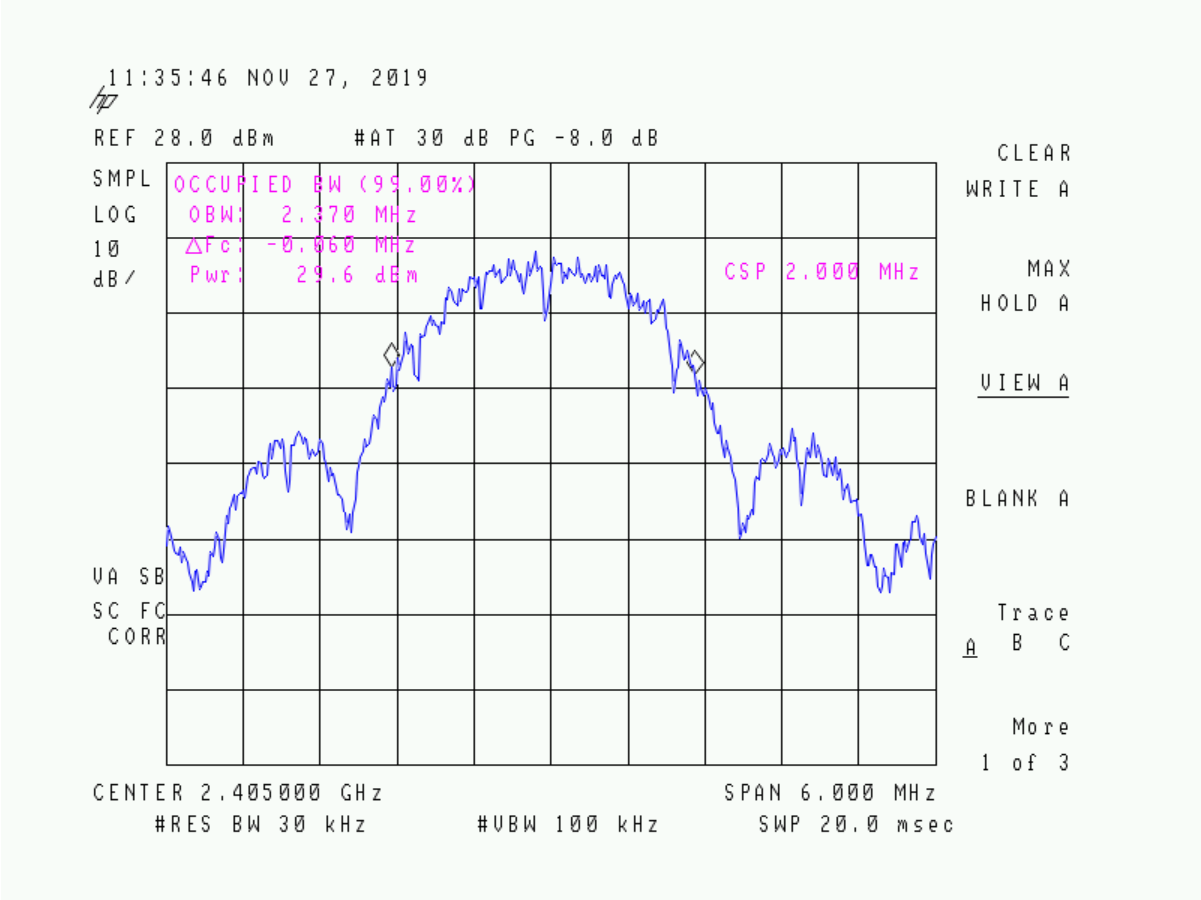


Figure 22. 99% Occupied Bandwidth - Low Channel

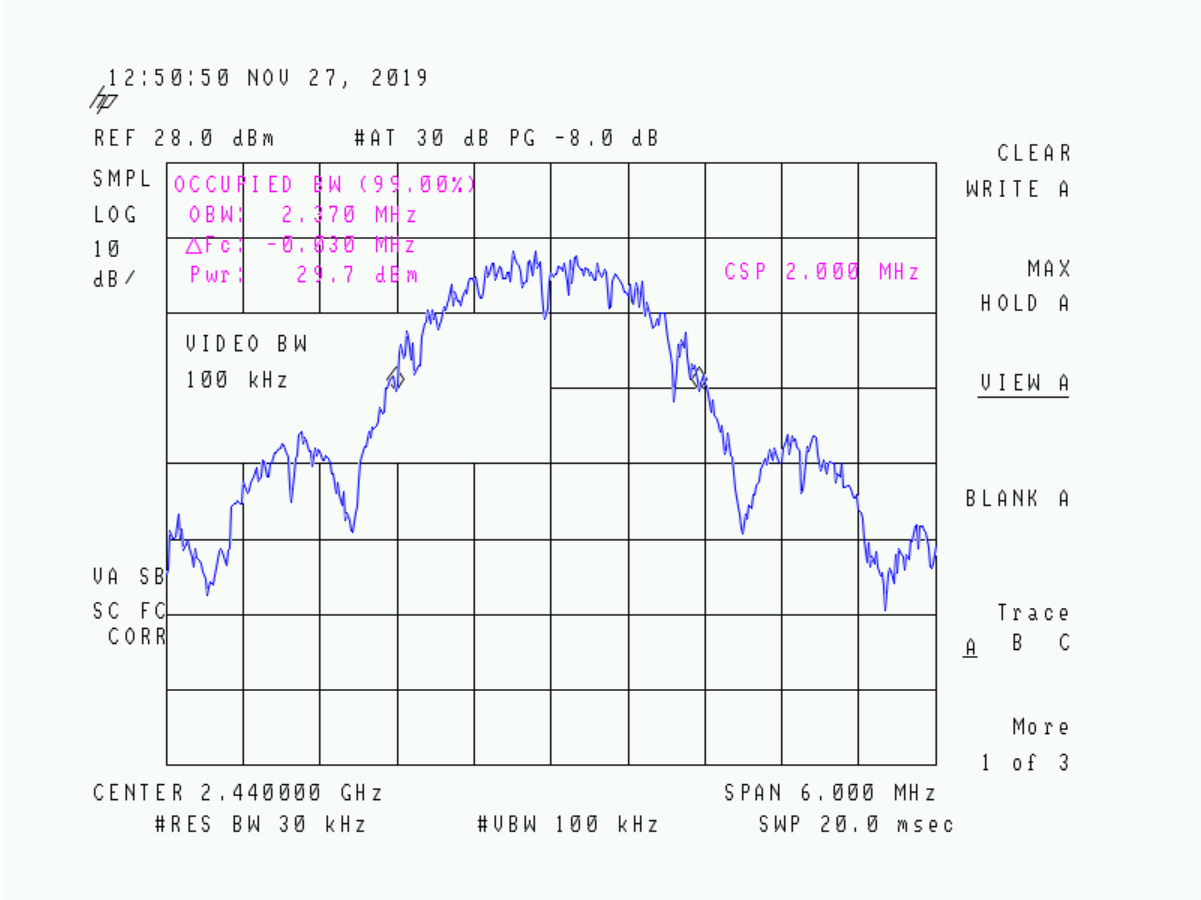


Figure 23. 99% Occupied Bandwidth - Mid Channel

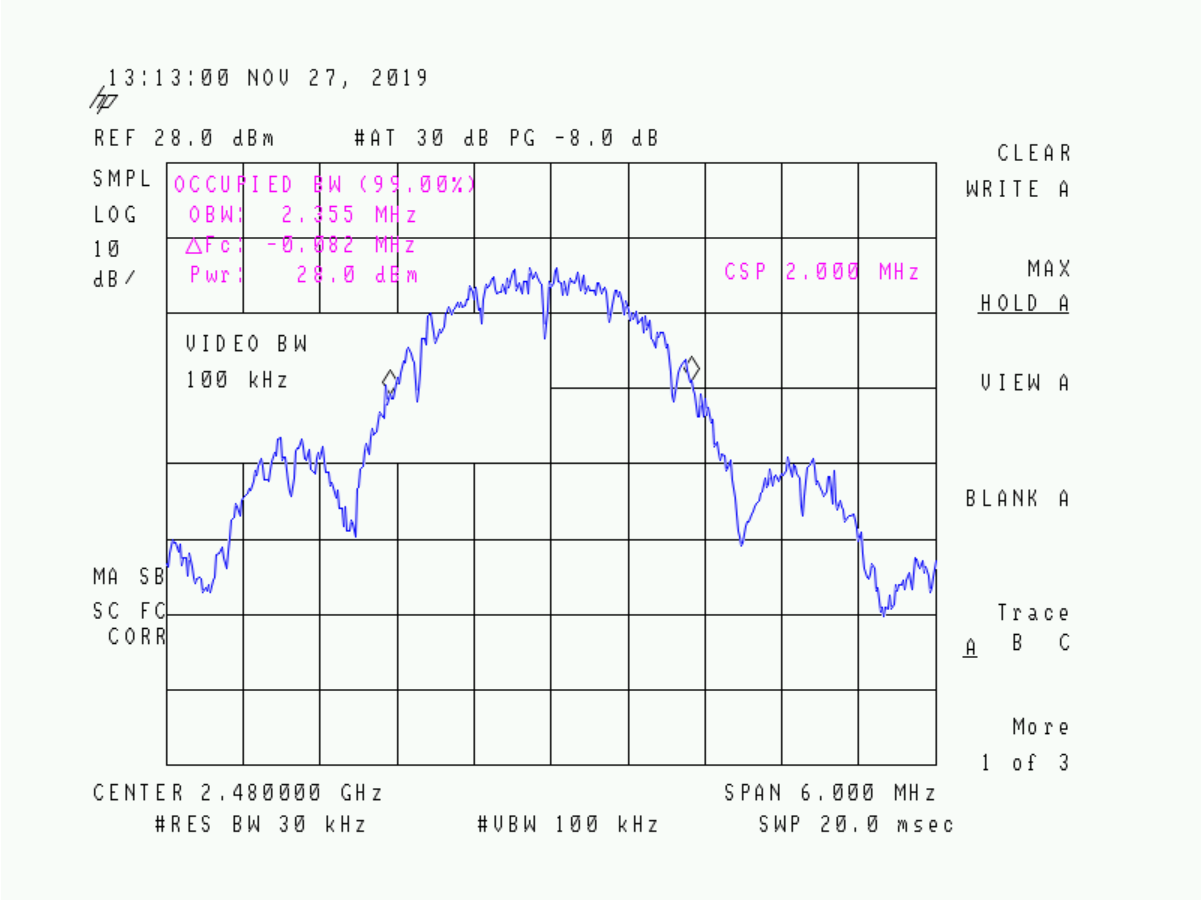


Figure 24. 99% Occupied Bandwidth - High Channel

2.16 Intentional Radiator Power Lines Conducted Emissions (CFR 15.207)

The power line conducted voltage emission measurements have been carried out in accordance with CFR 15.207, per ANSI C63.10:2013, Clause 6.2, with a spectrum analyzer connected to a LISN and the EUT placed into a continuous mode of transmission.

The worst-case results for conducted emissions were determined to be produced when the EUT was operating under continuous transmission. The worst case measurement was 3.6 dB from the applicable limit on the Phase line at 0.2743 MHz. All other emissions were at least 6.1 dB from the limit. Those results are shown in the table following.

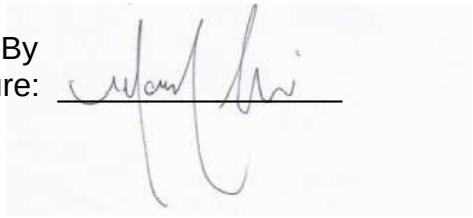
Table 10. Power Line Conducted Emissions 150 kHz to 30 MHz

Tested By: MA	Test: FCC Part 15,207			Client: Acuity Brands Lighting, Inc		
	Project: 19-0493			Model: 2.4 GHz Module		
Frequency (MHz)	**Test Data (dBuV)**	**LISN+CL (dB)**	**Corrected Results (dBuV)**	**Limits (dBuV)**	**Margin (dB)**	**Detector**
Phase @ 120 Vac/60Hz						
0.1500	47.79	0.08	47.87	56.0	8.1	**PK**
0.2743	44.64	2.72	47.36	51.0	3.6	**PK**
0.4178	35.98	2.73	38.71	47.5	8.8	**PK**
0.5650	36.11	0.25	36.36	46.0	9.6	**PK**
0.8487	37.82	0.59	38.41	46.0	7.6	**PK**
4.8500	39.82	0.08	39.90	46.0	6.1	**PK**
5.3130	41.29	0.00	41.29	50.0	8.7	**PK**
16.3300	29.48	0.57	30.05	50.0	20.0	**PK**
20.0500	29.79	0.82	30.61	50.0	19.4	**PK**
Neutral @ 120 Vac/60Hz						
0.1509	47.06	0.13	47.19	56.0	8.8	**PK**
0.2751	42.89	0.09	42.98	51.0	8.0	**PK**
0.4248	36.13	0.10	36.23	47.4	11.1	**PK**
0.8662	36.26	0.09	36.35	46.0	9.7	**PK**
4.8200	38.56	-0.03	38.53	46.0	7.5	**PK**
5.2130	39.47	0.16	39.63	50.0	10.4	**PK**
10.4300	39.47	0.47	39.94	50.0	10.1	**PK**
20.0000	29.32	1.19	30.51	50.0	19.5	**PK**

SAMPLE CALCULATION AT: 0.1500 MHz

Magnitude of Measured Frequency	47.79	dBuV
+LISN+ Cable Loss	0.08	dB
Corrected Result	47.87	dBuV/m

Test Date: November 27, 2019

Tested By
Signature: 

Name: Mark Afroozi

2.17 Unintentional Radiator and Intentional Radiator, Radiated Emissions (CFR 15.109, 15.209, RSS-Gen 8.9)

The test data provided herein is to support the verification requirement for radiated emissions coming from the EUT in a transmitting state per 15.209 and were investigated from 9kHz or the lowest operating clock frequency to 12.5 GHz and tested as detailed in ANSI C63.10:2013, Clause 6.4-6.6. Data is presented in the table below.

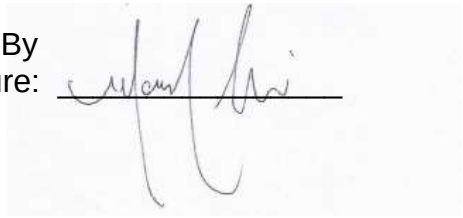
Radiated emissions within the band of 9 kHz to 30 MHz were investigated using a calibrated loop antenna and per the requirements of ANSI C63.10:2013.

Measurements were made with the analyzer's resolution bandwidth set to 120 kHz for measurements made below 1 GHz and 1 MHz for measurements made above 1 GHz. The video bandwidth was set to three times the resolution bandwidth (1 MHz RBW and 3 MHz VBW). The magnitude of each emission was maximized by rotating the turn-table 360 degrees clockwise and counterclockwise then raising and lowering the receiving antenna between 1 to 4 meters in height as part of the measurement procedure.

Table 11. Spurious Radiated Emissions (9 kHz – 30 MHz)

Tested By: MA	Test: FCC Part 15.109/15.209			Client: Acuity Brands Lighting, Inc.				
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factor**	**AF+CL-PA (dB/m)**	**Corrected Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector**
All emissions were more than 20 dB below the applicable limit.								

Test Date: November 26, 2019

Tested By
Signature: 

Name: Mark Afroozi

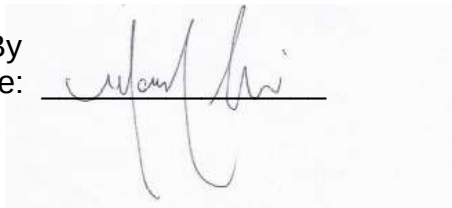
Table 12. Spurious Radiated Emissions (30 MHz – 1 GHz)

Tested By: MA	Test: FCC Part 15.109/15.209				Client: Acuity Brands Lighting, Inc			
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factors**	**AF+CL-PA (dB)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**DETECTOR PK / QP/AVG**
38.96	37.12	--	-14.45	22.67	40.0	3m./HORZ	17.3	**PK**
75.02	40.08	--	-17.05	23.03	40.0	3m./HORZ	17.0	**PK**
107.28	42.67	--	-15.70	26.97	43.5	3m./HORZ	16.5	**PK**
38.96	48.30	--	-15.35	32.95	40.0	3m./VERT	7.1	**QP**
44.40	45.12	--	-16.16	28.96	40.0	3m./VERT	11.0	**QP**
67.77	41.02	--	-17.69	23.33	40.0	3m./VERT	16.7	**PK**
107.46	46.24	--	-15.10	31.14	43.5	3m./VERT	12.4	**PK**
153.73	36.21	--	-12.31	23.90	43.5	3m./VERT	19.6	**PK**
313.39	37.87	--	-9.60	28.27	46.0	3m./HORZ	17.7	**PK**
All other emissions were more than 20 dB below the applicable limit.								

Sample Calculation at 38.96 MHz:

Magnitude of Measured Frequency	37.12	dBuV
+Additional Factor (Duty cycle correction)	N/A	dB
+Antenna Factor + Cable Loss - Amplifier Gain	-14.45	dB/m
Corrected Result	22.67	dBuV/m

Test Date: November 26, 2019

Tested By
Signature: 

Name: Mark Afroozi

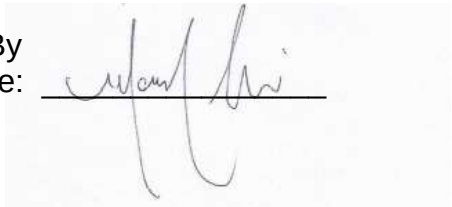
Table 13. Spurious Radiated Emissions (above 1 GHz)

Tested By: MA	Test: FCC Part 15.109/15.209				Client: Acuity Brands Lighting, Inc.			
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factors**	**AF+CL-PA (dB)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**DETECTOR PK / QP/AVG**
6366.20	30.12	--	-0.29	29.83	49.5	1.0m./HORZ	19.7	**PK**
9949.50	30.12	--	7.10	37.22	49.5	1.0m./HORZ	12.3	**PK**
11429.10	28.95	--	12.73	41.68	49.5	1.0m./HORZ	7.8	**PK**
7714.30	30.68	--	8.33	39.01	49.5	1.0m./VERT	10.5	**PK**
9568.60	30.16	--	6.52	36.68	49.5	1.0m./VERT	12.8	**PK**
11537.52	29.09	--	14.14	43.23	49.5	1.0m./VERT	6.3	**PK**
All other emissions were more than 20 dB below the applicable limit.								

Sample Calculation at 6366.20 MHz:

Magnitude of Measured Frequency	30.12	dBuV
+Additional Factor (Duty cycle correction)	N/A	dB
+Antenna Factor + Cable Loss - Amplifier Gain	-0.29	dB/m
Corrected Result	29.83	dBuV/m

Test Date: November 26, 2019

Tested By
Signature: 

Name: Mark Afroozi

2.18 Measurement Uncertainty

The measurement uncertainties given were calculated using the method detailed in CISPR 16-4-2:2011. A coverage factor of k=2 was used to give a level of confidence of approximately 95%.

2.18.1 Conducted Emissions Measurement Uncertainty

Measurement Uncertainty (within a 95% confidence level) for this test is ±2.78 dB.

2.18.2 Radiated Emissions Measurement Uncertainty

For a measurement distance of 3 m the measurement uncertainty (with a 95% confidence level) for this test using a Biconical Antenna (30 MHz to 200 MHz) is ±5.3 dB. This value includes all elements of measurement.

The measurement uncertainty (with a 95% confidence level) for this test using a Log Periodic Antenna (200 MHz to 1000 MHz) is ±5.1 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna (Above 1000 MHz) is ±5.1 dB.

3 Test Results

The EUT is deemed to have met the requirements of the standards cited within the test report when tested as detailed in the test report.