



UL LLC
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Order Number: 10878508
Date: August 6, 2015
Model: MC100

Electromagnetic Compatibility Test Report

For

Chamberlain Group Inc.

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Order#: 10878508
Model Number: MC100
Client Name: Chamberlain Group Inc.

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Test Report Details

Tests Performed By: **UL LLC**
333 Pfingsten Rd.
Northbrook, IL 60062

Tests Performed For: **Chamberlain Group Inc.**
845 Larch Av
Elmhurst, IL 60126

Applicant Contact: **Hank Sieradzki**
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Test Report Date: **August 6, 2015**

Product Type: **Universal Periodic Transmitter**

Product standards **FCC Part 15, Subpart C, 15.231 & RSS-210**

Model Number: **MC100**

EUT Category: **Wireless Device**

Testing Start Date: **July 15, 2015**

Date Testing Complete: **August 3, 2015**

Overall Results: **Compliant**

UL LLC reports apply only to the specific samples tested under stated test conditions. All samples tested were in good operating condition throughout the entire test program. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. UL LLC shall have no liability for any deductions, inferences or generalizations drawn by the client or others from UL LLC issued reports. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

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Report Revision History

Revision Date	Description	Revised By	Revision Reviewed By
None	-	-	-

1.0 GENERAL - Product Description

1.1 Equipment Description

The equipment under test is a universal MC100 keyfob push button transmitter used with various brand garage door operators. The transmitter uses 310MHz, 315MHz, 318MHz, 372.5MHz, and 390MHz. It is user programmable for use with specific garage door operators.

1.2 Device Configuration During Test

1.2.1 Equipment Used During Test:

Use	Product Type	Manufacturer	Model	Comments
EUT	Periodic Transmitter	Chamberlain Group Inc.	MC100	Mode 1,3,5,6,7,8,9 Sample: SMP50410 Mode 2, 4 Sample: SMP50465

Note: **EUT** - Equipment Under Test, **AE** - Auxiliary/Associated Equipment, or **SIM** - Simulator (Not Subjected to Test)

1.2.2 Input/Output Ports:

Port #	Name	Type*	Cable Max. >3m (Y/N)	Cable Shielded (Y/N)	Comments
0	Enclosure	N/E	—	—	None

Note:
 AC = AC Power Port DC = DC Power Port N/E = Non-Electrical
 I/O = Signal Input or Output Port (Not Involved in Process Control)
 TP = Telecommunication Ports

1.2.3 Power Interface:

Mode # /Rated	Voltage (V)	Current (A)	Power (W)	Frequency (DC/AC-Hz)	Phases (#)	Comments
1	3	-	-	dc	-	Battery Operated

1.3 EUT Configurations

Mode #	Description
1	EUT with fresh batteries set to transmit. Initial measurements of the fundamental were conducted with the transmitter in X-Axis, Y-Axis and Z-Axis. Worst case axis found was the X-Axis.

1.4 EUT Operation Modes

Mode #	Description
1	EUT transmitting per specific modes

1.5 Rational for EUT Configuration

Mode #	Description
1	Below is a list of possible modes. Each mode may have different output power and duty cycle. In some cases if frequency was the same (mode 8 and mode 1), peak levels were measured with device set to mode 8 but duty cycle was applied from specific mode. This resulted in worst case condition measurements.
Mode #	Frequency MHz
1	315
2	390
3	318
4	390
5	315
6	390
7	310
8	310, 315, 390
9	372.5

2.0 Summary

The tests listed in the Summary of Testing section of this report have been performed and the results recorded by UL LLC in accordance with the procedures stated in each test requirement and specification. The applicant determined the list of tests performed were applicable to the Equipment Under Test. As a result, the subject product has been verified to comply or not comply as noted in the Summary of Testing with each test specification. The test results relate only to the items tested.

2.1 Deviations from standard test methods

None

2.2 Device Modifications Necessary for Compliance

None

2.3 Reference Standards

Standard Number	Standard Name	Standard Date
FCC Part 15, Subpart C, 15.231	Code of Federal Regulations, Part 15, Radio Frequency Devices	2015
RSS-210	License – exempt Radio Apparatus (All Frequency Bands): Category I Equipment	Issue 8
ANSI C63.10	American National Standard for Testing Unlicensed Wireless Devices	2009

2.4 Results Summary

Requirement – Test	Result (Compliant / Non-Compliant)*
Line Conducted Emissions	N/A – EUT is battery operated only
Occupied Bandwidth	Compliant
Cease Operation	Compliant
Pulse Train and Duty Cycle	Compliant
Fundamental Frequency & Spurious Radiated Emissions*	Compliant

Test Engineer:



Bartlomiej Mucha(Ext.41216)
Staff Engineer
UL Verification Services - EMC

Reviewer:



Michael Ferrer
Program Manager
UL Verification Services - EMC

Any information and documentation involving UL Mark services are provided on behalf of UL LLC (UL) or any authorized licensee of UL.

3.0 Calibration of Equipment Used for Measurement

All test equipment and test accessories are calibrated on a regular basis. The maximum time between calibrations is one year or the manufacturers' recommendation, whichever is less.

All test equipment calibrations are traceable to the National Institute of Standards and Technology (NIST); therefore, all test data recorded in this report is traceable to NIST.

4.0 EMISSIONS TEST RESULTS

The emissions tests were performed according to following regulations:

FCC	47 CFR Part 15 – Intentional Radiators
IC	RSS-210 and RSS-Gen License - exempt Radio Apparatus

Unless specified otherwise in the individual Methods, the tests shall be conducted under the following ambient conditions. Confirmation of these conditions shall be verified at the time the test is conducted.

Ambient Temperature, °C	22.5 ± 2.5	Relative Humidity, %	45 ± 15	Barometric Pressure, mBar	950 ± 150
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Sample Calculations

Radiated Field Strength and Conducted Emissions data contained within this report is calculated on the following basis:

- Field Strength (dBuV/m) = Meter Reading (dBuV) + AF (dB/m) + (-Gain (dB)) + Cable Loss (dB)
- Conducted Voltage (dBuV) = Meter Reading (dBuV) + Cable Loss (dB) + LISN IL (dB)
- Conducted Current (dBuA) = Meter Reading (dBuV) + Cable Loss (dB) - Transducer Factor (dBohms)

4.1 Mode#1 Test Data

4.1.1 Test Conditions and Results – Occupied Bandwidth

Test Description	Measurements were made in the laboratory environment. A Dipole (or equivalent) antenna tuned to the transmit frequency was attached to the input of a spectrum analyzer. The device was operated and the spectrum analyzer resolution bandwidth set per the appropriate standard.	
Basic Standard	47 CFR Part 15.231(c)	
Occupied Bandwidth Limits		
0.25% of Center Frequency (315MHz: 787.50kHz)		

Table 1 Occupied Bandwidth Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	1	1
Supplementary information: None		

Table 2 Occupied Bandwidth Spectrum Analyzer Settings

Resolution Bandwidth	Occupied Bandwidth Requirements	
	dBc	% PWR
10kHz	-20	99
Supplementary information: None		

Table 3 Occupied Bandwidth Test Result Summary

Center Frequency	20dB BW Measured (kHz)	99% BW Measured (kHz)
315MHz	17.44	38.408

Figure 1 – Bandwidth Graph 315MHz – 20dB

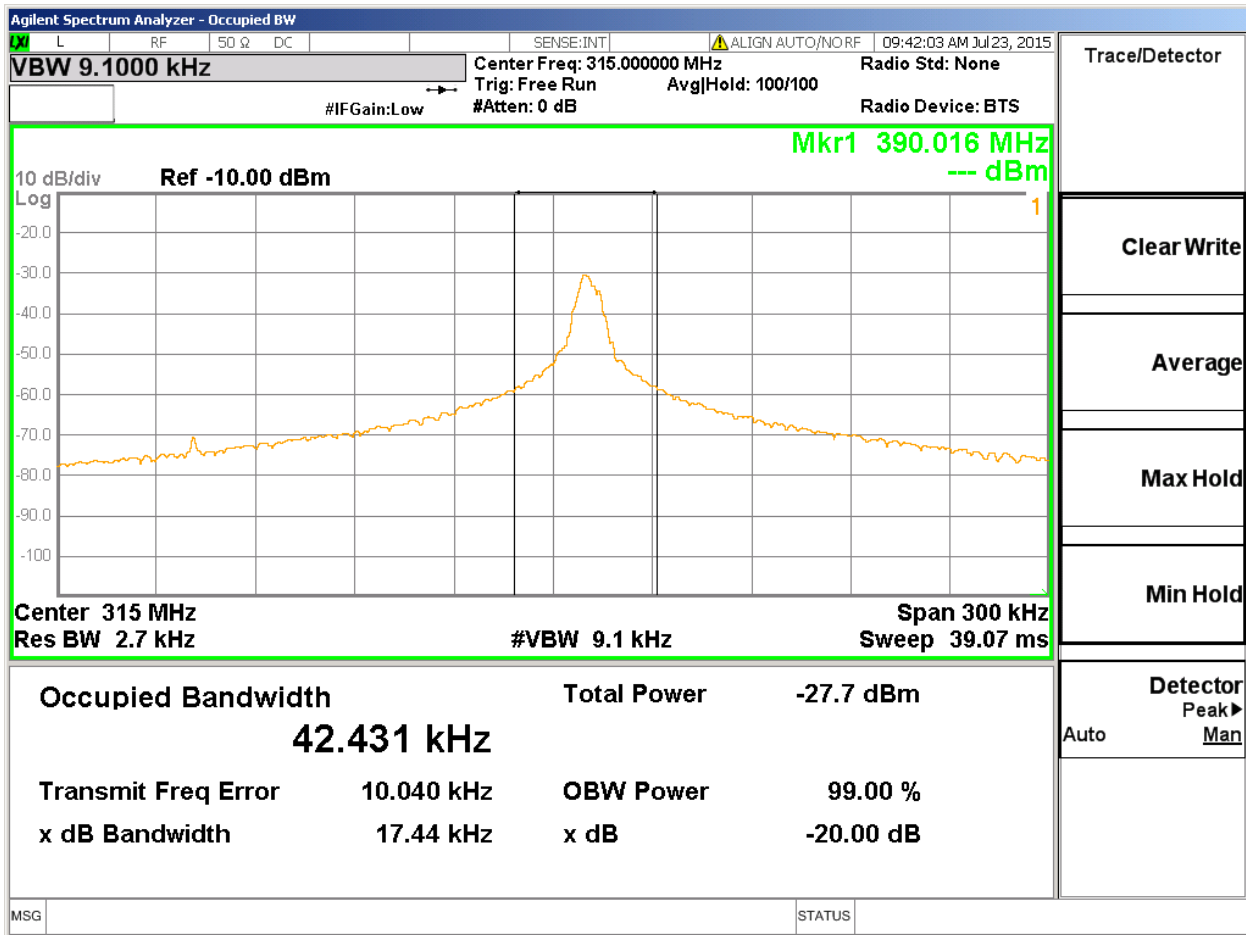
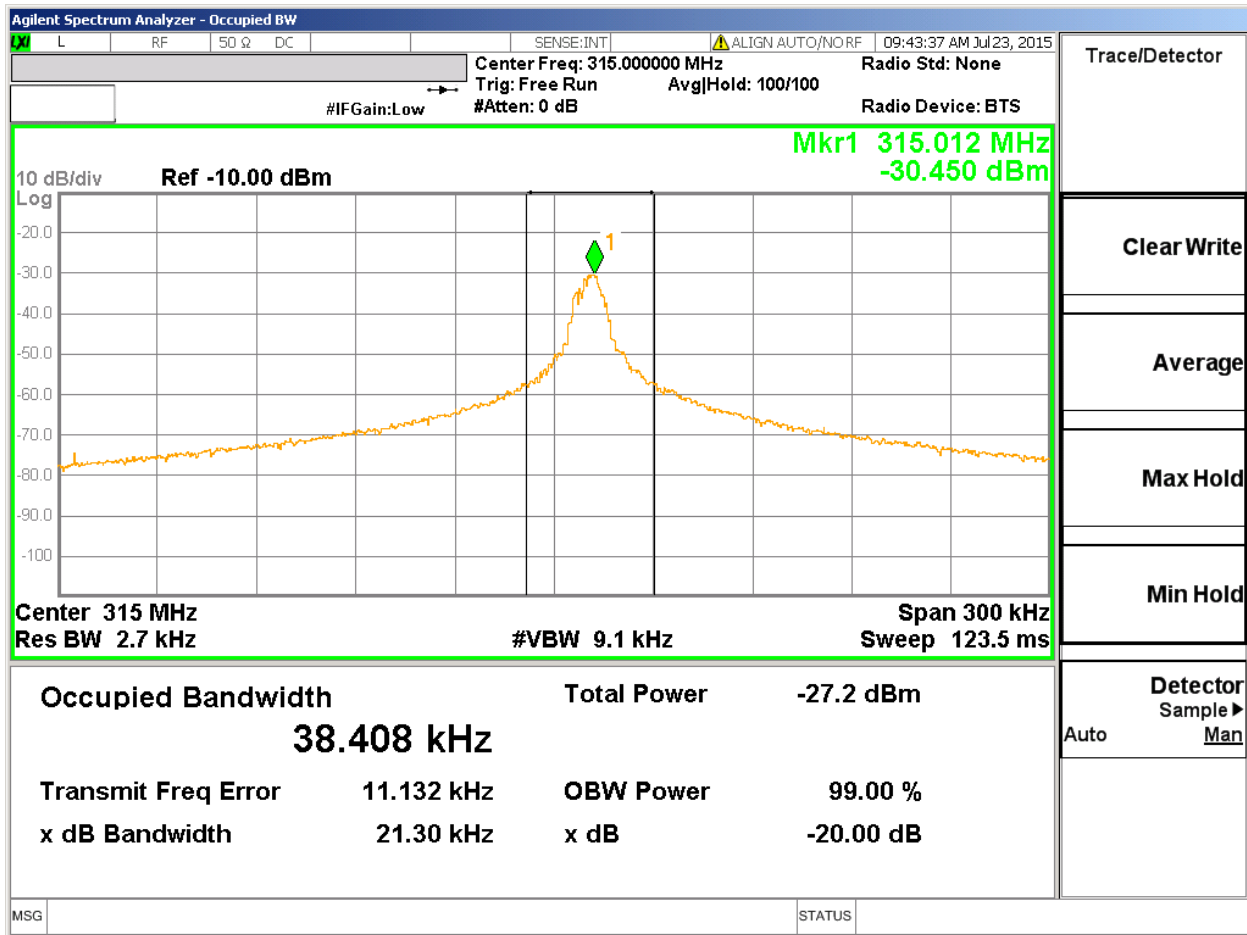


Figure 2 – Bandwidth Graph 315MHz – 99%



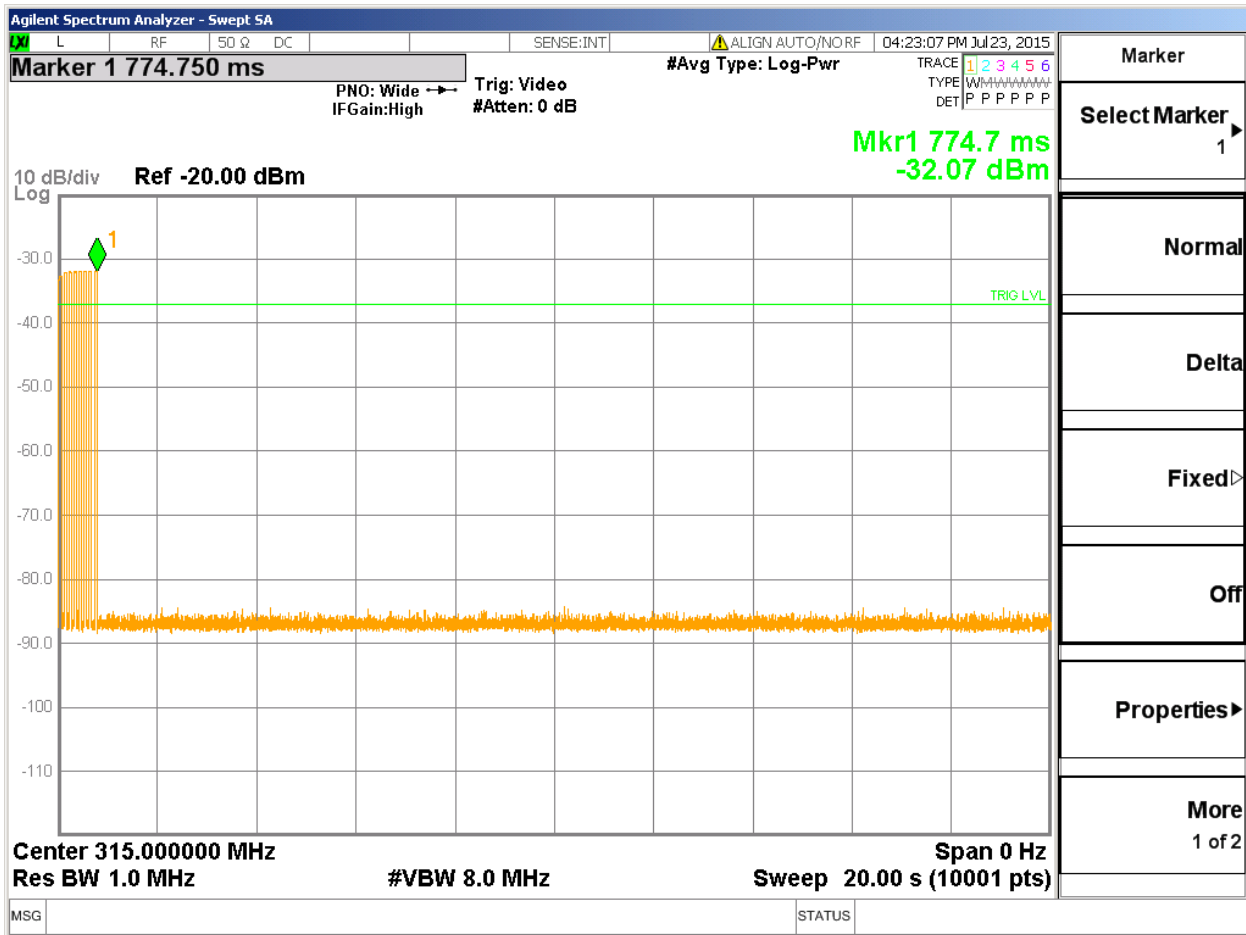
4.1.2 Test Conditions and Results – Cease Operation

Test Description	Measurements were made in the laboratory environment. A Dipole (or equivalent) antenna tuned to the transmit frequency was attached to the input of a spectrum analyzer. The device was operated and the transmission time measured with the spectrum analyzer set to zero span at the fundamental frequency.	
Basic Standard	47 CFR Part 15.231(a)	
Cease Operation Limits		
The transmissions shall stop within 5 seconds of either a button being released or if automatically controlled transmissions shall be stopped 5 seconds after transmissions begin.		

Table 4 Cease Operation Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	1	1
Supplementary information: None		

Figure 3 Cease Operation Graph 315MHz



4.1.3 Test Conditions and Results – Pulse Train

Test Description	Measurements were made in the laboratory environment. A Dipole (or equivalent) antenna tuned to the transmit frequency was attached to the input of a spectrum analyzer. The pulse train was measured with the spectrum analyzer set to zero span at the fundamental frequency.	
Basic Standard	FCC Part 15 Subpart A, 15.35	
Pulse Train Limits		
There are no limits for this test. This data is used to calculate the averaging correction factor that is applied to the measured peak radiated emissions results.		

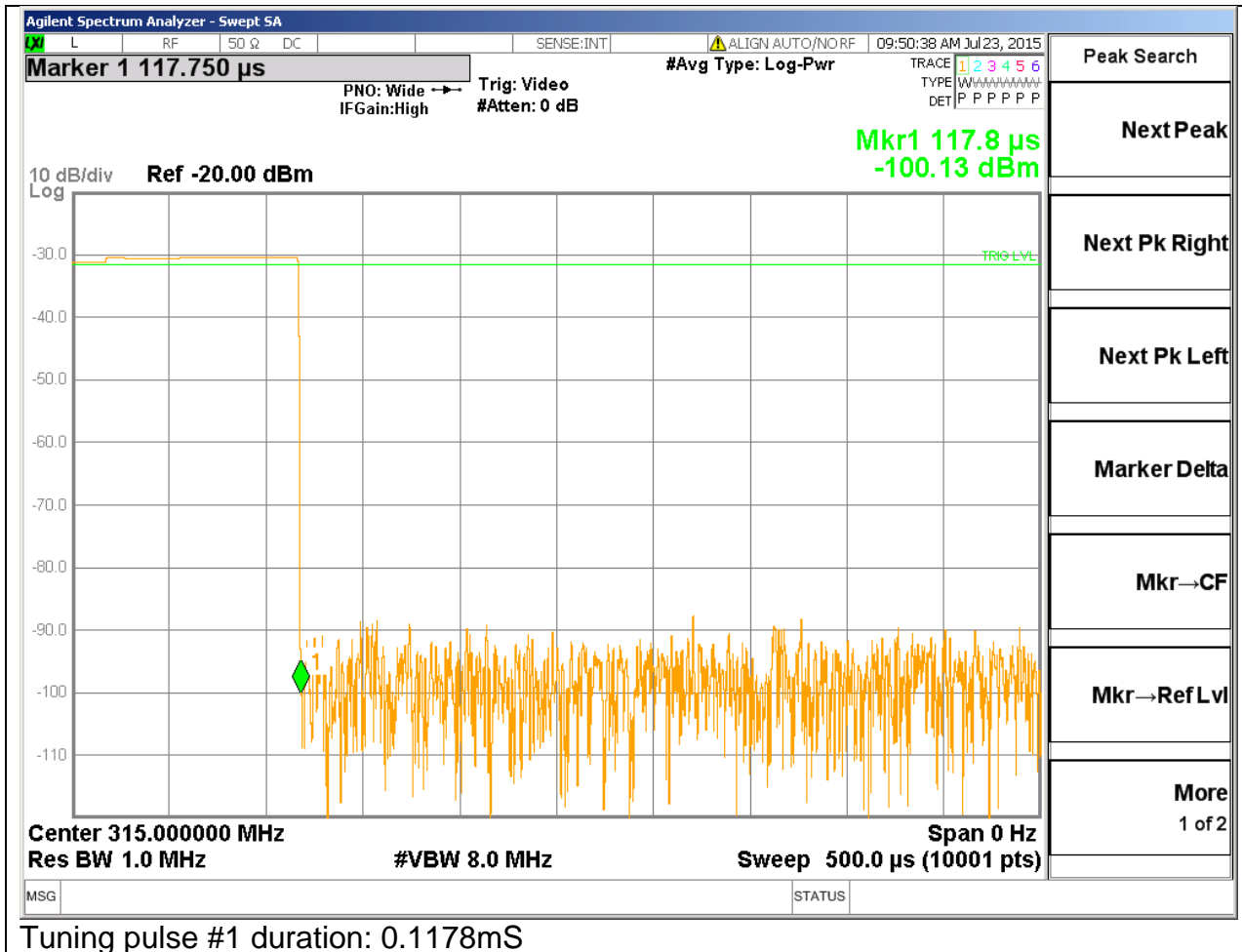
Table 5 Pulse Train Configuration Settings

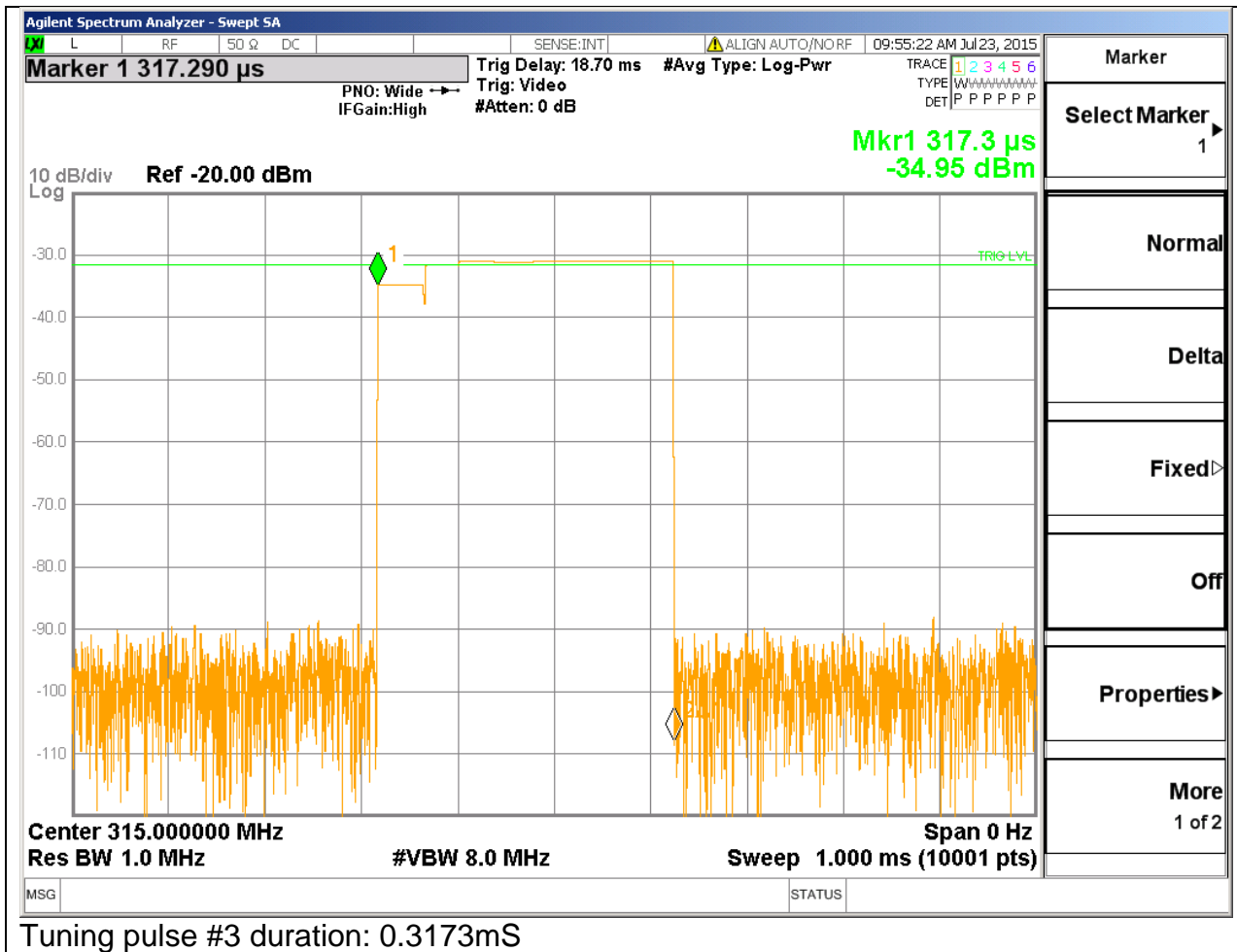
Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	1	1
Supplementary information: None		

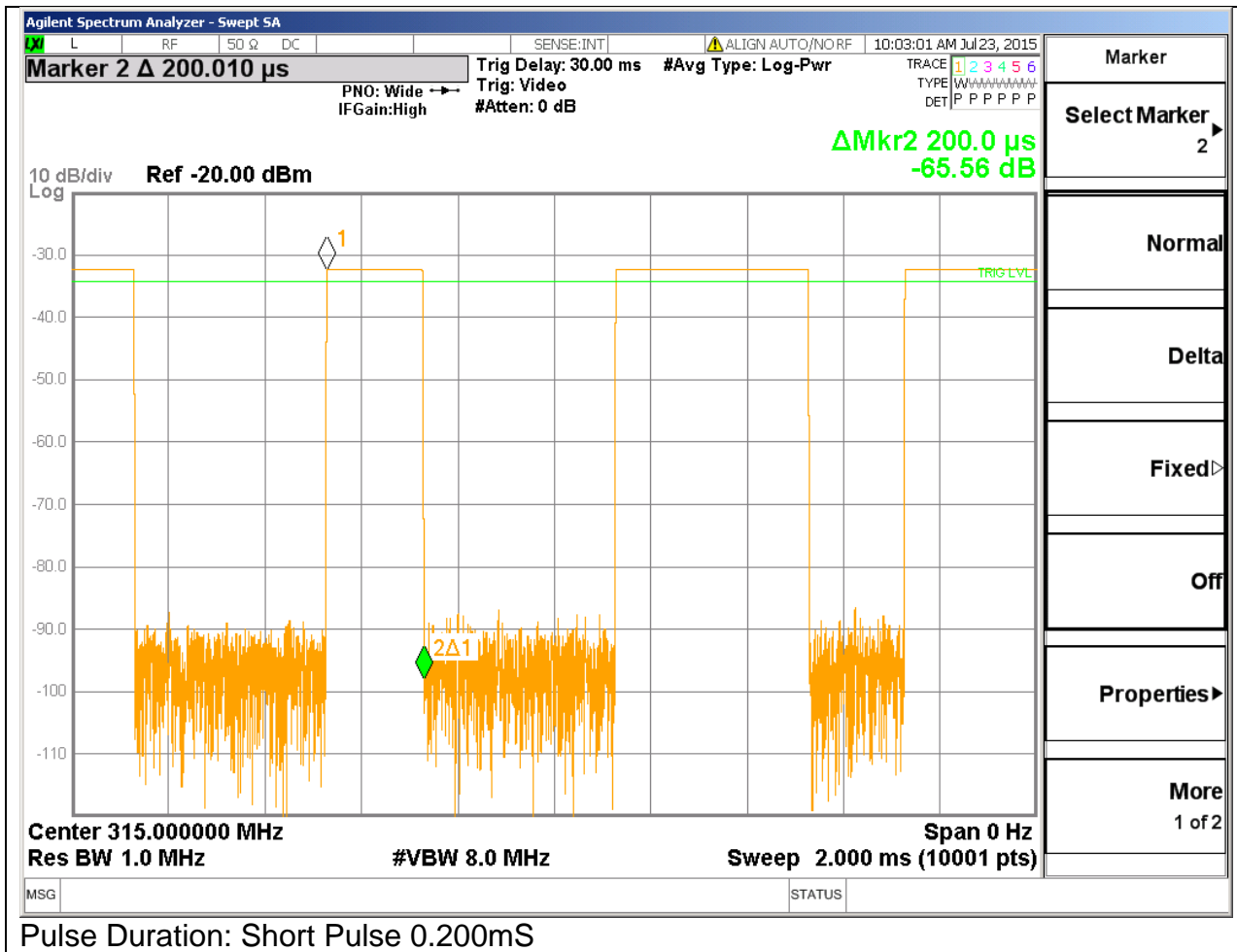
Table 6 Pulse Train Calculation

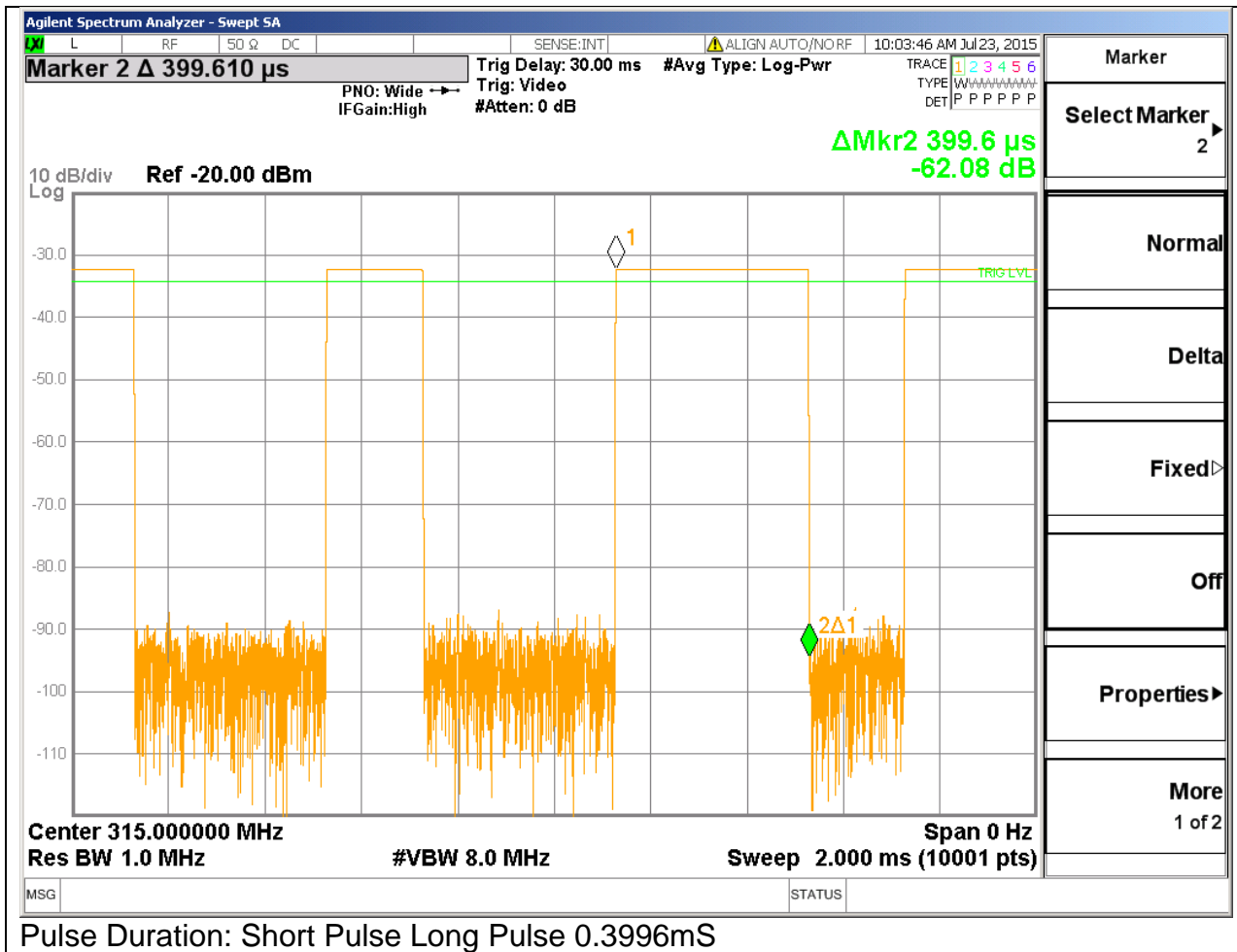
TX Frequency	Total TX time	Total Transmission period or 100ms whichever is lesser	DC Correction Factor (dB) $20\log\left(\frac{PulseWidth}{Period}\right)$
315MHz	$0.1178+0.00343+0.3173+(46\times 0.200)+(30\times 0.3996)=21.62mS$	100mS	-13.30dB
Worst Case Duty Cycle: Worst case duty cycle was calculated over 100mS including the tuning pulses. The manufacturer declared duty cycle as -12.36dB, measured duty cycle is used for all radiated emissions data.			

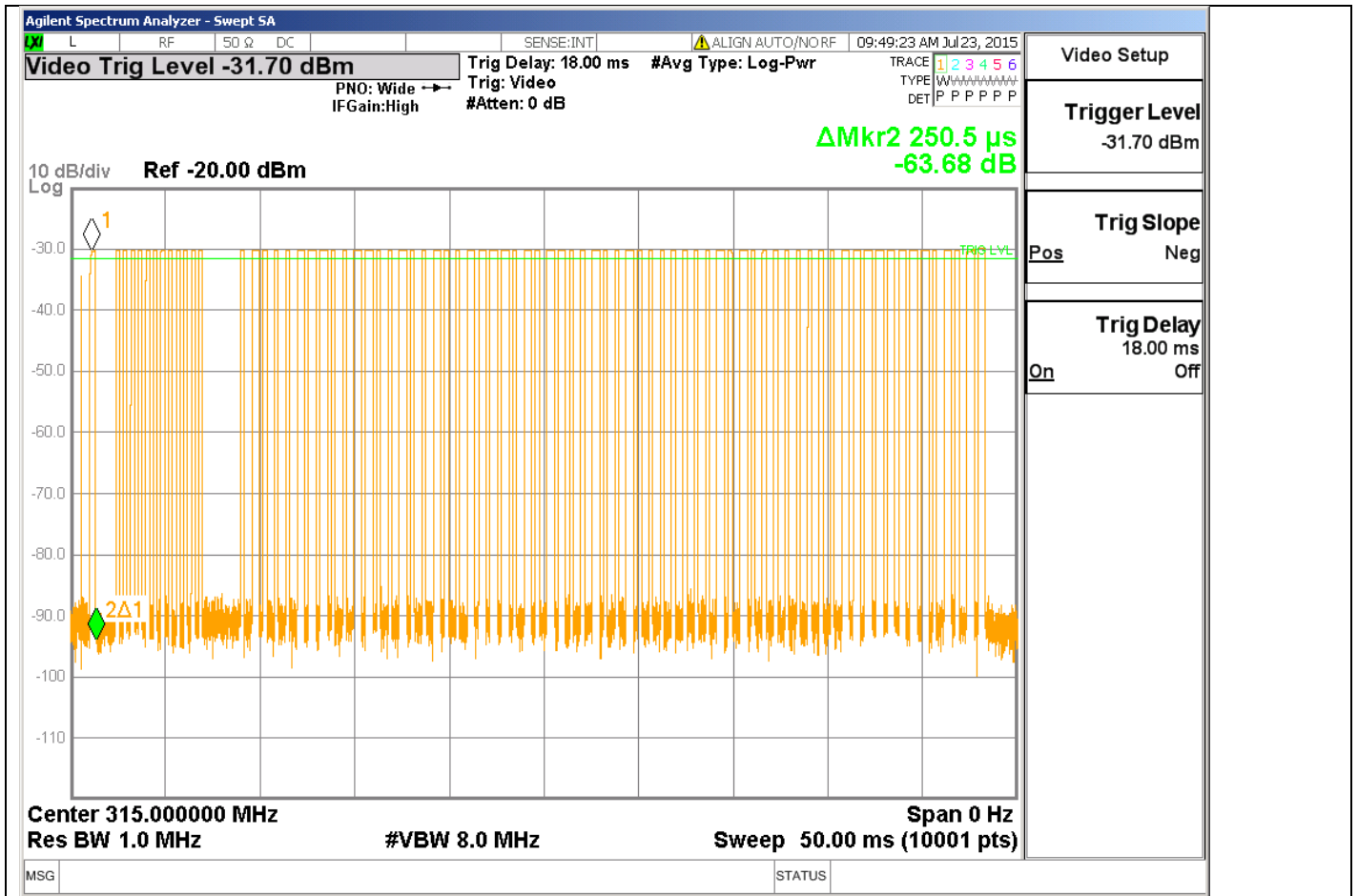
Figure 4 Pulse Train Graphs for 315MHz



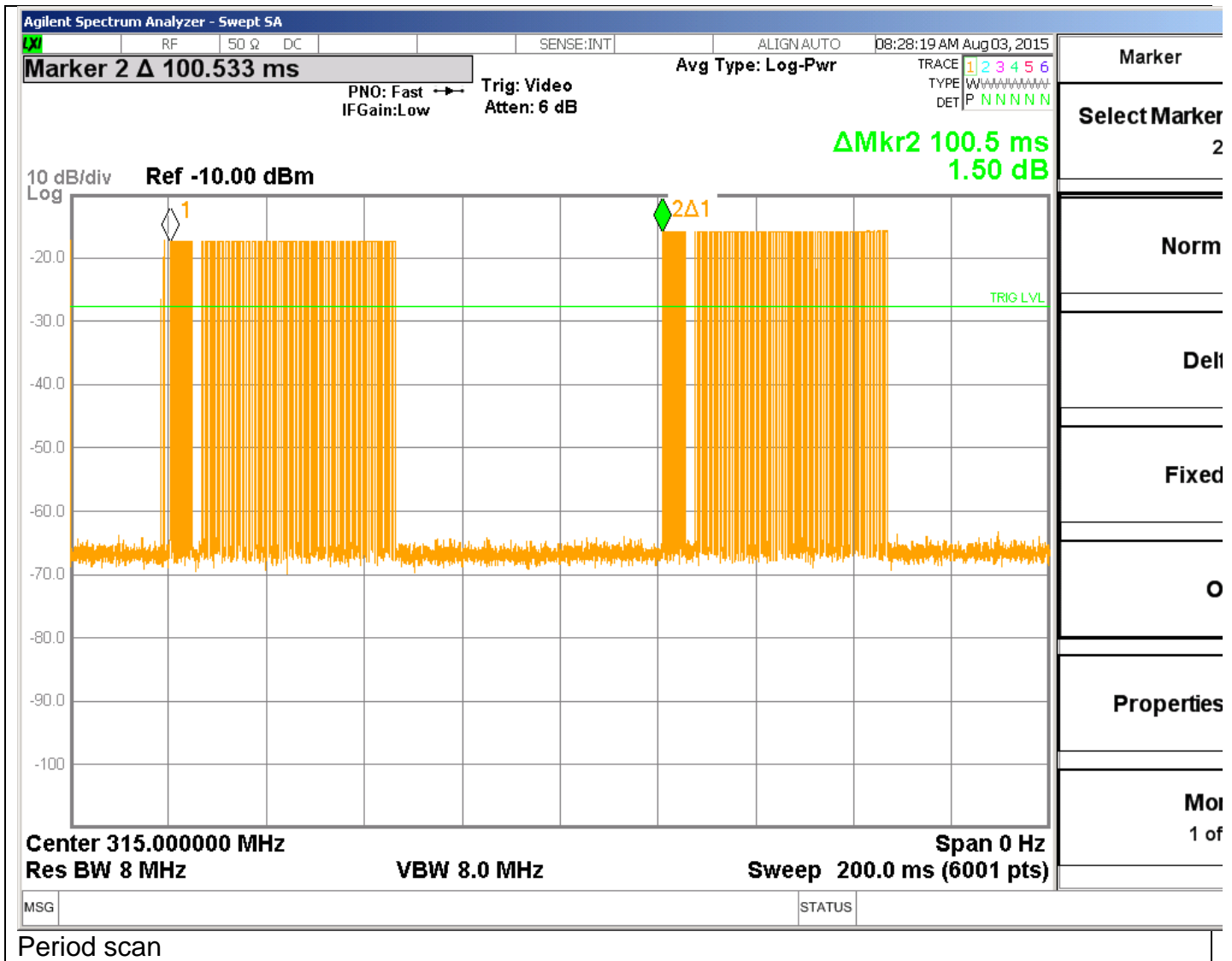








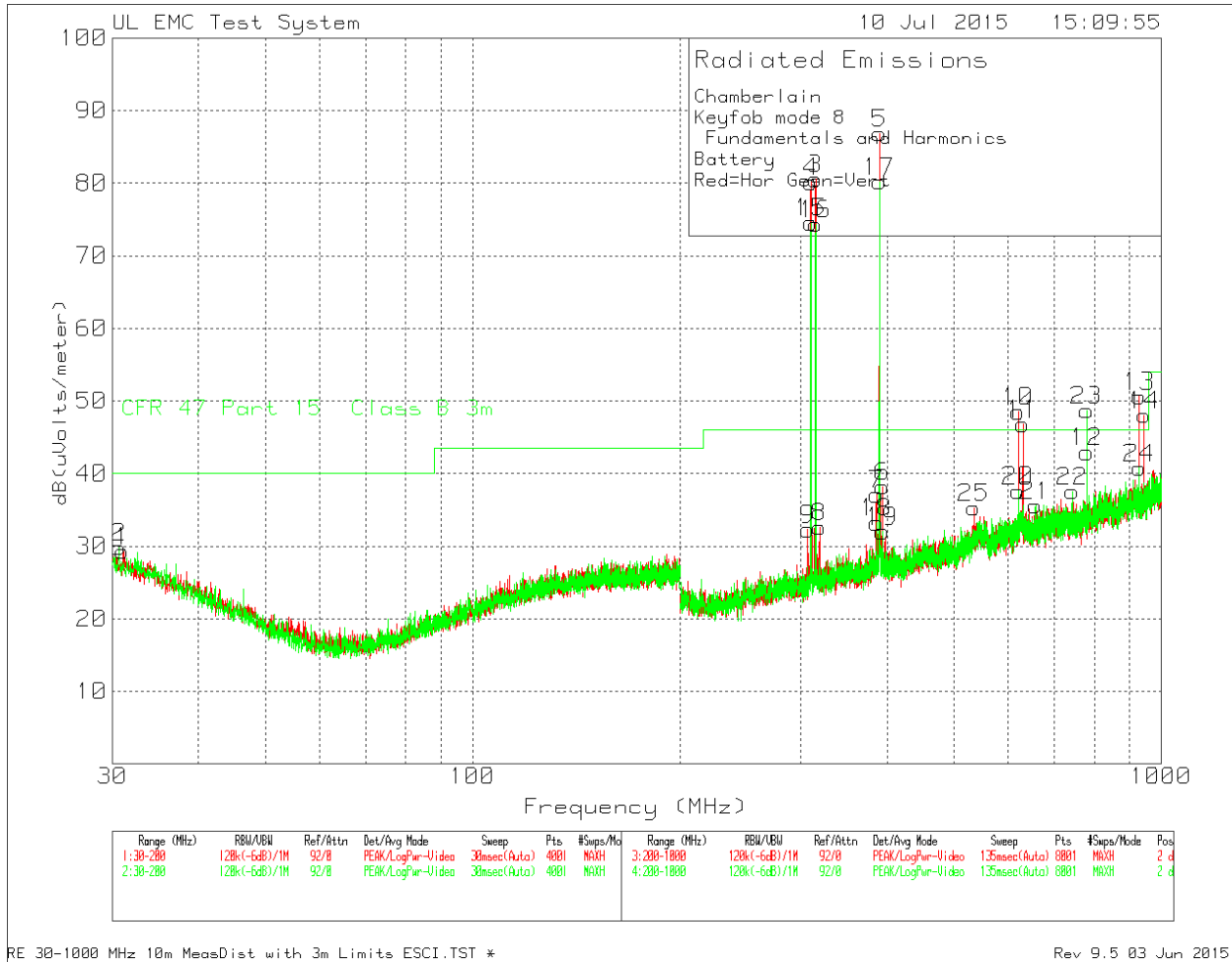
Number of Pulses: 46 Short, 30 Long & Tuning Pulses



4.1.4 Test Conditions and Results – RADIATED EMISSIONS Fundamental and Spurious

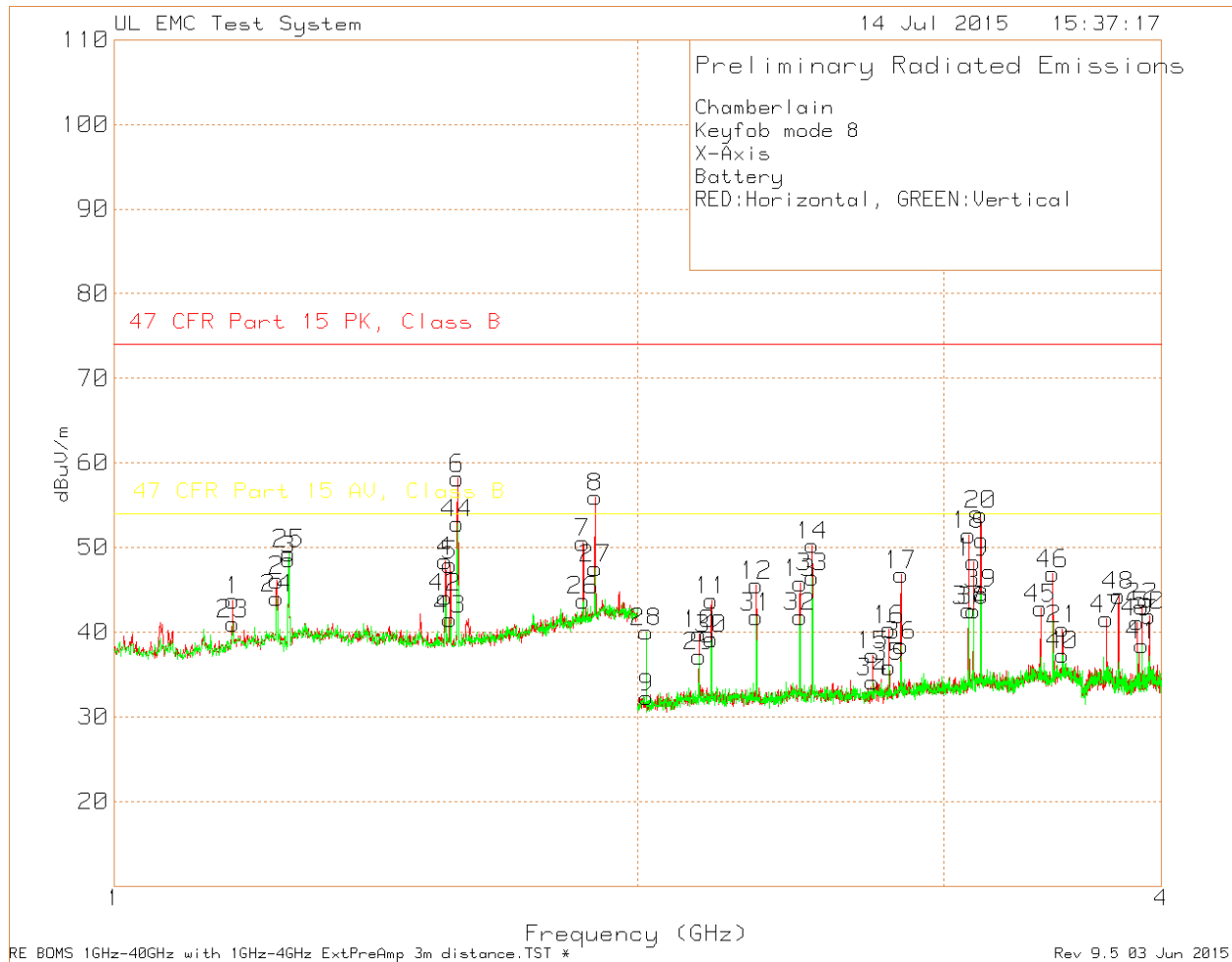
Test Description	Measurements were made in a 10-meter semi-anechoic chamber that complies to CISPR 16/ANSI C63.10:2009. Preliminary (peak) measurements were performed at an antenna to EUT separation distance of 3-meter as noted. The EUT was rotated 360° about its azimuth with the receive antenna located at various heights in both horizontal and vertical polarities. Final measurements (quasi-peak or average as noted) were then performed by rotating the EUT 360° and adjusting the receive antenna height from 1 to 4-meters. All frequencies were investigated in both horizontal and vertical antenna polarity, where applicable.	
Basic Standard	47 CFR Part 15 subpart C, and RSS-210	
UL LPG	80-EM-S0029	
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	30MHz – 1GHz	3 meter distance
	1GHz – 4GHz	3 meter distance
Out of band spurious emissions limit		
Frequency (MHz)	Limit (dB μ V/m)	
	Quasi-Peak	Peak
30 - 88	40.00	NA
88 - 216	43.52	NA
216 - 960	46.02	NA
960 - 1000	54	NA
Above 1000 (FCC)	NA	54 (at 3-meter)
Fundamental Frequency Limits and Non-restricted band Harmonic Limits		
Frequency (MHz)	Limit (dB μ V/m) @ 3m distance All harmonics except those in restricted bands must be attenuated by 20dB or more	
	Average - Fundamental	Peak - Fundamental
315	75.62	95.62
Supplementary information: See section 4.1.3 for duty cycle information.		

Figure 5 Radiated Emissions Graph (Below 1GHz)



Above scan is for mode #8. Mode #8 uses the same frequencies as mode #1 with few additional ones. The drive level for mode #8 is higher than drive for mode #1 therefore conducting a scan with mode #8 was considered as worst case.

Figure 6 Radiated Emissions Graph (Above 1GHz)



Above scan is for mode #8. Mode #8 uses the same frequencies as mode #1 with few additional ones. The drive level for mode #8 is higher than drive for mode #1 therefore conducting a scan with mode #8 was considered as worst case.

Table 7 - Radiated Emissions Data Points 315MHz – Below 1GHz

Test Frequency (MHz)	Meter Reading (dBuV)	Detector	Antenna Factor dB/m	Path Factor dB	Peak Level dBuV/m	DC Factor dB	Average Level with DC dBuV/m	Peak Limit dBuV/m	Peak Margin dB	Average Limit dBuV/m	Average Margin dB	Azimuth [Degs]	Height [cm]	Polarity	Notes
315.013	61	Pk	14.3	8	83.3	-12.36	70.94	95.62	-12.32	75.62	-4.68	27	100	H	1
315.0153	40.1	Pk	14.3	8	62.4	-12.36	50.04	95.62	-33.22	75.62	-25.58	112	102	V	1
315.016	55.31	Pk	14.3	8	77.61	-12.36	65.25	95.62	-18.01	75.62	-10.37	224	238	H	2
315.013	58.23	Pk	14.3	8	80.53	-12.36	68.17	95.62	-15.09	75.62	-7.45	301	192	V	2
315.015	54.88	Pk	14.3	8	77.18	-12.36	64.82	95.62	-18.44	75.62	-10.8	227	231	H	3
315.016	58.65	Pk	14.3	8	80.95	-12.36	68.59	95.62	-14.67	75.62	-7.03	313	189	V	3
630.034	11.87	Pk	20.7	9.2	41.77	-12.36	29.41	66.02	-24.25	46.02	-16.61	318	139	H	1
630.0175	6.25	Pk	20.7	9.2	36.15	-12.36	23.79	66.02	-29.87	46.02	-22.23	217	103	V	1
630.041	8.25	Pk	20.7	9.2	38.15	-12.36	25.79	66.02	-27.87	46.02	-20.23	351	125	H	2
630.0275	10.94	Pk	20.7	9.2	40.84	-12.36	28.48	66.02	-25.18	46.02	-17.54	308	101	V	2
630.039	9.73	Pk	20.7	9.2	39.63	-12.36	27.27	66.02	-26.39	46.02	-18.75	54	154	H	3
630.0185	9.31	Pk	20.7	9.2	39.21	-12.36	26.85	66.02	-26.81	46.02	-19.17	327	191	V	3
945.0499	12.4	Pk	23.9	10.5	46.8	-12.36	34.44	66.02	-19.22	46.02	-11.58	69	165	H	1
945.0824	8.22	Pk	23.9	10.5	42.62	-12.36	30.26	66.02	-23.4	46.02	-15.76	287	114	V	1
945.0399	12.03	Pk	23.9	10.5	46.43	-12.36	34.07	66.02	-19.59	46.02	-11.95	41	125	V	2
945.0624	8.8	Pk	23.9	10.5	43.2	-12.36	30.84	66.02	-22.82	46.02	-15.18	175	324	H	2
945.0529	11.61	Pk	23.9	10.5	46.01	-12.36	33.65	66.02	-20.01	46.02	-12.37	5	166	H	3
945.0674	12.69	Pk	23.9	10.5	47.09	-12.36	34.73	66.02	-18.93	46.02	-11.29	76	122	V	3
Notes:															
1 - X- Axis (Laying Flat) 315MHz															
2 - Z- Axis (Straight Up) 315MHz															
3 - Y- Axis (Sideways) 315MHz															
Pk - Peak detector															

Below 1GHz all measurement data was collected with transmitter set to mode #1 and duty cycle for mode #1.

Table 8 - Radiated Emissions Data Points 315MHz – Above 1GHz

Marker No.	Test Frequency (GHz)	Meter Reading (dBuV)	Detector	Antenna Factor dB/m	Path Factor dB	Peak Level dBuV/m	DC Factor dB	Average Level with DB dBuV/m	Peak Limit dBuV/m	Peak Margin dB	Average Limit dBuV/m	Average Margin dB	Azimuth [Degs]	Height [cm]	Polarity
3	1.26	75.88	Pk	28.9	-56.21	48.57	-12.36	36.21	74	-25.43	54	-17.79	0-360	100	H
25	1.26	76.59	Pk	28.9	-56.21	49.28	-12.36	36.92	74	-24.72	54	-17.08	0-360	100	V
6	1.575	85.09	Pk	28.2	-54.64	58.65	-12.36	46.29	74	-15.35	54	-7.71	350	179	H
44	1.575	78.46	Pk	28.2	-54.64	52.02	-12.36	39.66	74	-21.98	54	-14.34	77	254	V
8	1.89	78.94	Pk	31.3	-53.57	56.67	-12.36	44.31	74	-17.33	54	-9.69	49	123	H
27	1.891	69.81	Pk	31.3	-53.58	47.53	-12.36	35.17	74	-26.47	54	-18.83	0-360	150	V
11	2.205	74.4	Pk	21.8	-52.46	43.74	-12.36	31.38	74	-30.26	54	-22.62	0-360	150	H
30	2.205	69.86	Pk	21.8	-52.46	39.2	-12.36	26.84	74	-34.8	54	-27.16	0-360	100	V
14	2.5202	81.07	Pk	22.1	-51.82	51.35	-12.36	38.99	74	-22.65	54	-15.01	33	209	H
33	2.52	76.21	Pk	22.1	-51.82	46.49	-12.36	34.13	74	-27.51	54	-19.87	0-360	150	V
17	2.835	75.11	Pk	22.3	-50.62	46.79	-12.36	34.43	74	-27.21	54	-19.57	0-360	99	H
36	2.835	66.71	Pk	22.3	-50.62	38.39	-12.36	26.03	74	-35.61	54	-27.97	0-360	100	V
20	3.1502	81.97	Pk	22.9	-50.81	54.06	-12.36	41.7	74	-19.94	54	-12.3	65	127	H
39	3.151	72.5	Pk	22.9	-50.83	44.57	-12.36	32.21	74	-29.43	54	-21.79	0-360	100	V
9	2.024	64.39	Pk	21.2	-53.29	32.3	0	-	74	-41.7	54	-21.7	0-360	150	H
45	3.41	69.97	Pk	23.5	-50.66	42.81	0	-	74	-31.19	54	-11.19	0-360	99	H
46	3.465	74.39	Pk	23.5	-50.99	46.9	0	-	74	-27.1	54	-7.1	0-360	99	H
47	3.721	67.86	Pk	23.6	-49.9	41.56	0	-	74	-32.44	54	-12.44	0-360	150	H
48	3.781	71.77	Pk	24	-51.46	44.31	0	-	74	-29.69	54	-9.69	0-360	150	H
49	3.876	68.41	Pk	23.9	-51.15	41.16	0	-	74	-32.84	54	-12.84	0-360	150	H
50	3.938	68.86	Pk	24	-50.95	41.91	0	-	74	-32.09	54	-12.09	0-360	99	H
28	2.023	72.09	Pk	21.2	-53.27	40.02	0	-	74	-33.98	54	-13.98	0-360	150	V

Pk - Peak detector

For above 1GHz all measurement data was collected with transmitter set to mode #8 (higher output power) and duty cycle from mode #1. Because all emission levels are under the limit it was considered worst case and it was considered not necessary to re-do measurement with transmitter set to mode #1.

4.2 Mode#2 Test Data

4.2.1 Test Conditions and Results – Occupied Bandwidth

Test Description	Measurements were made in the laboratory environment. A Dipole (or equivalent) antenna tuned to the transmit frequency was attached to the input of a spectrum analyzer. The device was operated and the spectrum analyzer resolution bandwidth set per the appropriate standard.	
Basic Standard	47 CFR Part 15.231(c)	
Occupied Bandwidth Limits		
0.25% of Center Frequency (390MHz: 975.00kHz)		

Table 9 Occupied Bandwidth Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	1	1
Supplementary information: None		

Table 10 Occupied Bandwidth Spectrum Analyzer Settings

Resolution Bandwidth	Occupied Bandwidth Requirements	
	dBc	% PWR
10kHz	-20	99
Supplementary information: None		

Table 11 Occupied Bandwidth Test Result Summary

Center Frequency	20dB BW Measured (kHz)	99% BW Measured (kHz)
390MHz	24.26	47.916

Figure 7 –20dB Bandwidth Graph

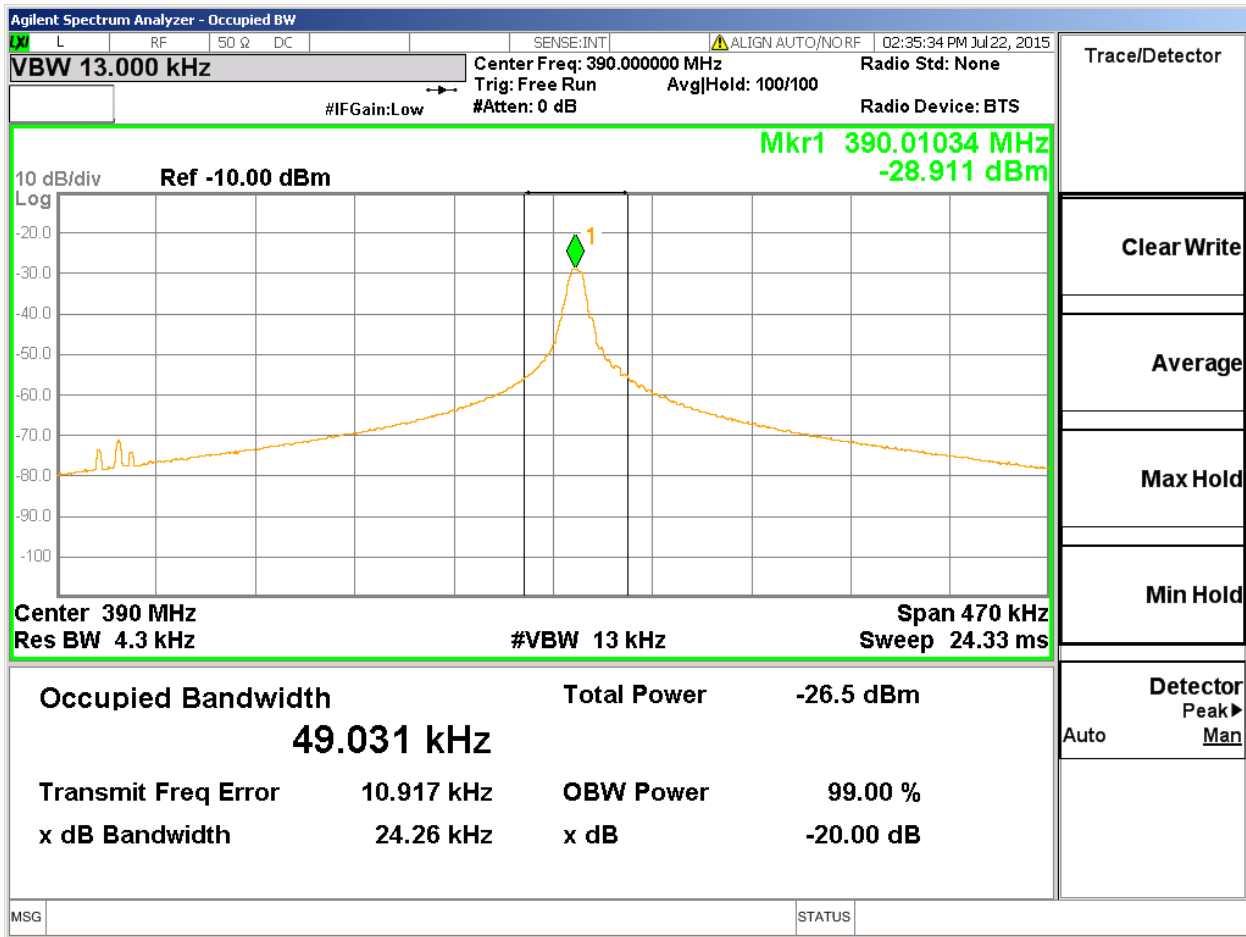
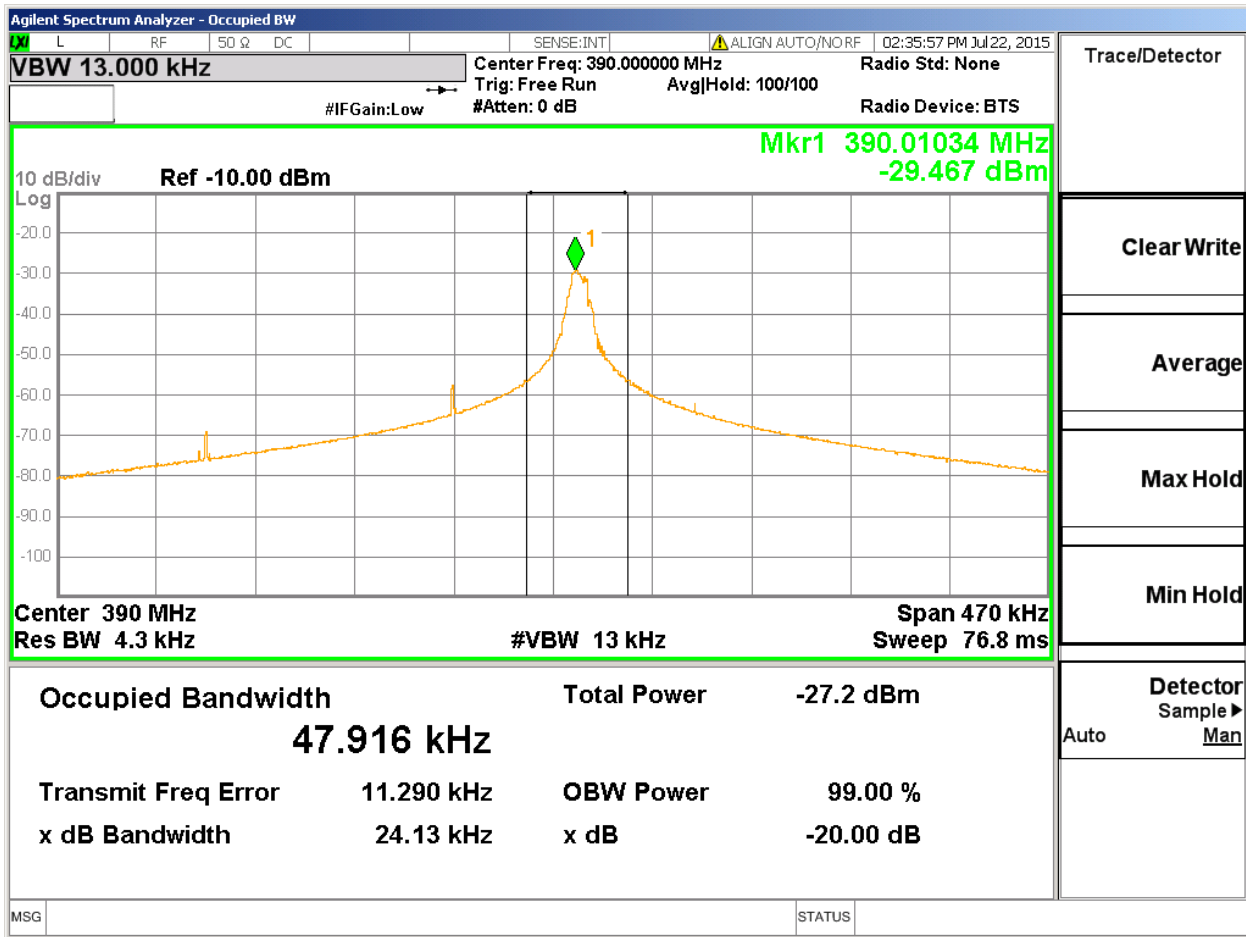


Figure 8 – 99% Bandwidth Graph



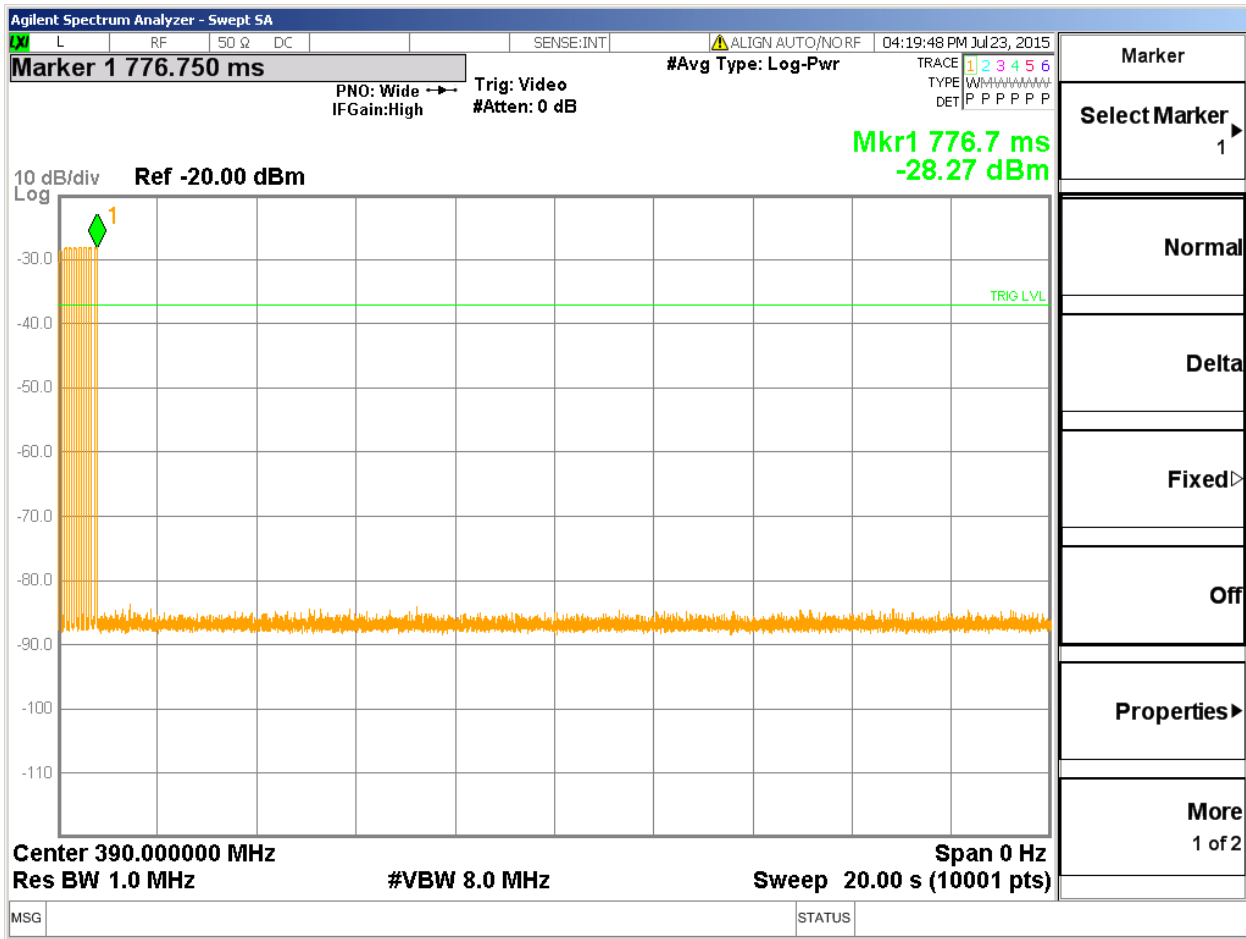
4.2.2 Test Conditions and Results – Cease Operation

Test Description	Measurements were made in the laboratory environment. A Dipole (or equivalent) antenna tuned to the transmit frequency was attached to the input of a spectrum analyzer. The device was operated and the transmission time measured with the spectrum analyzer set to zero span at the fundamental frequency.	
Basic Standard	47 CFR Part 15.231(a)	
Cease Operation Limits		
The transmissions shall stop within 5 seconds of either a button being released or if automatically controlled transmissions shall be stopped 5 seconds after transmissions begin.		

Table 12 Cease Operation Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	1	1
Supplementary information: None		

Figure 9 Cease Operation Graph 390MHz



4.2.3 Test Conditions and Results – Pulse Train

Test Description	Measurements were made in the laboratory environment. A Dipole (or equivalent) antenna tuned to the transmit frequency was attached to the input of a spectrum analyzer. The pulse train was measured with the spectrum analyzer set to zero span at the fundamental frequency.	
Basic Standard	FCC Part 15 Subpart A, 15.35	
Pulse Train Limits		
There are no limits for this test. This data is used to calculate the averaging correction factor that is applied to the measured peak radiated emissions results.		

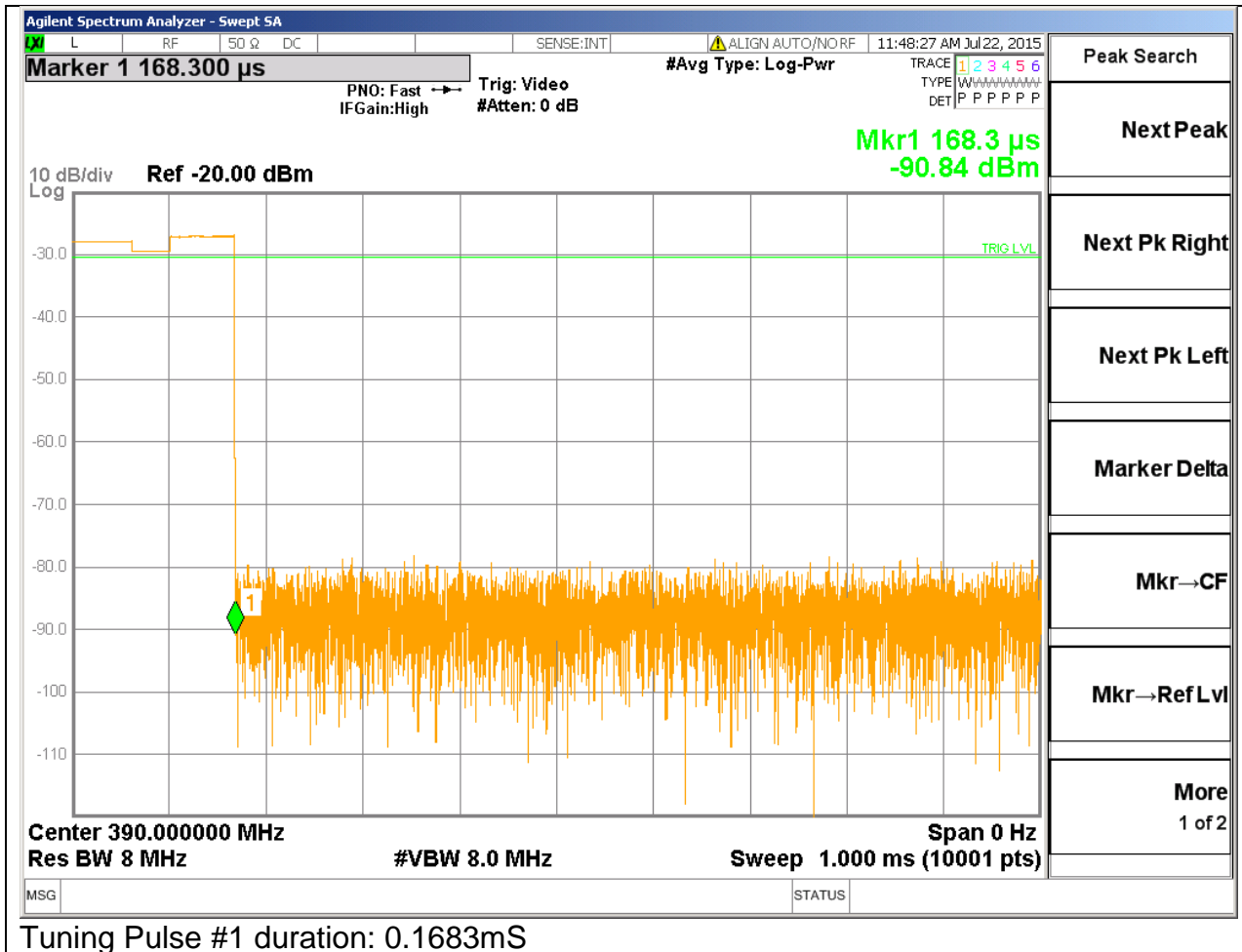
Table 13 Pulse Train Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	1	1
Supplementary information: None		

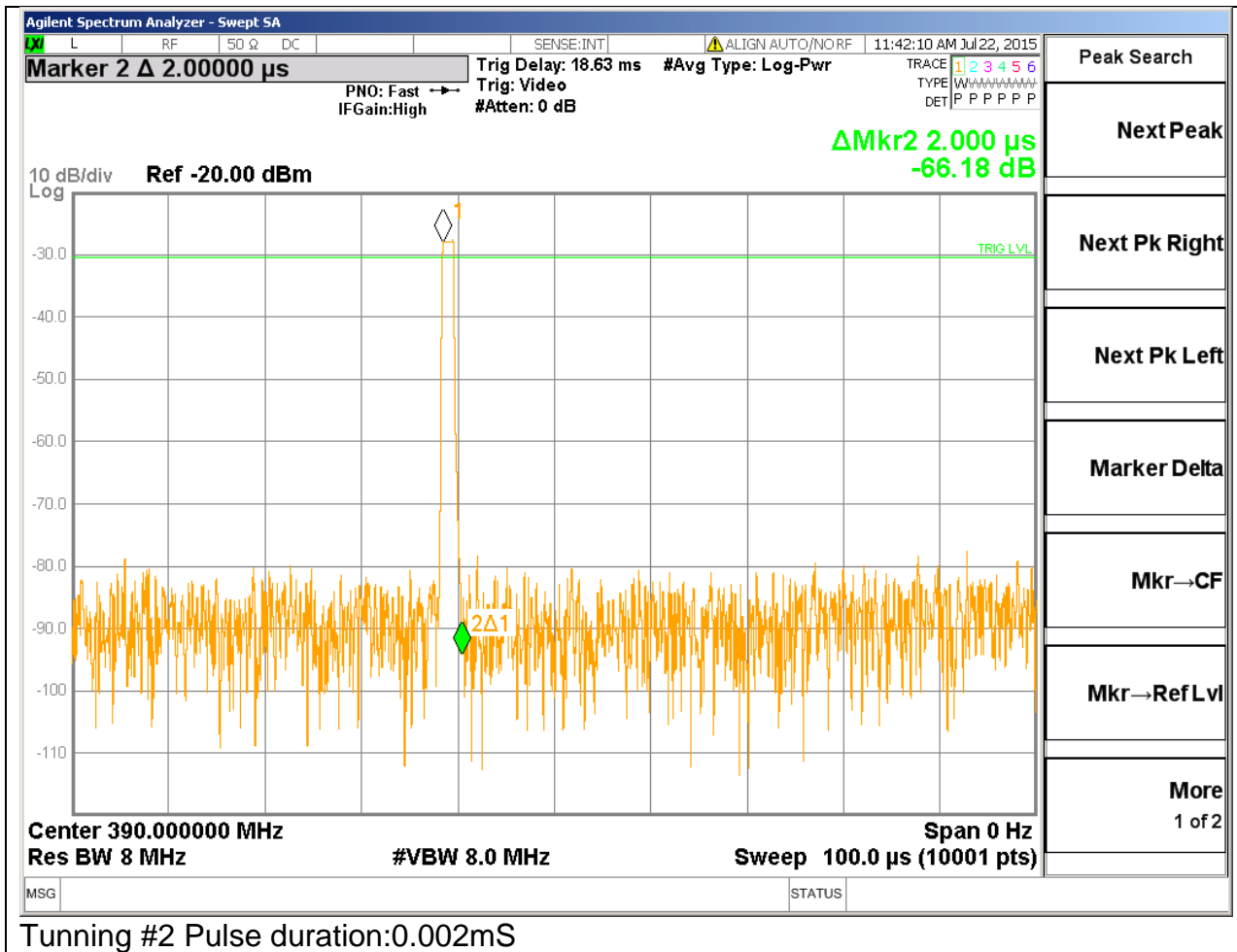
Table 14 Pulse Train Calculation

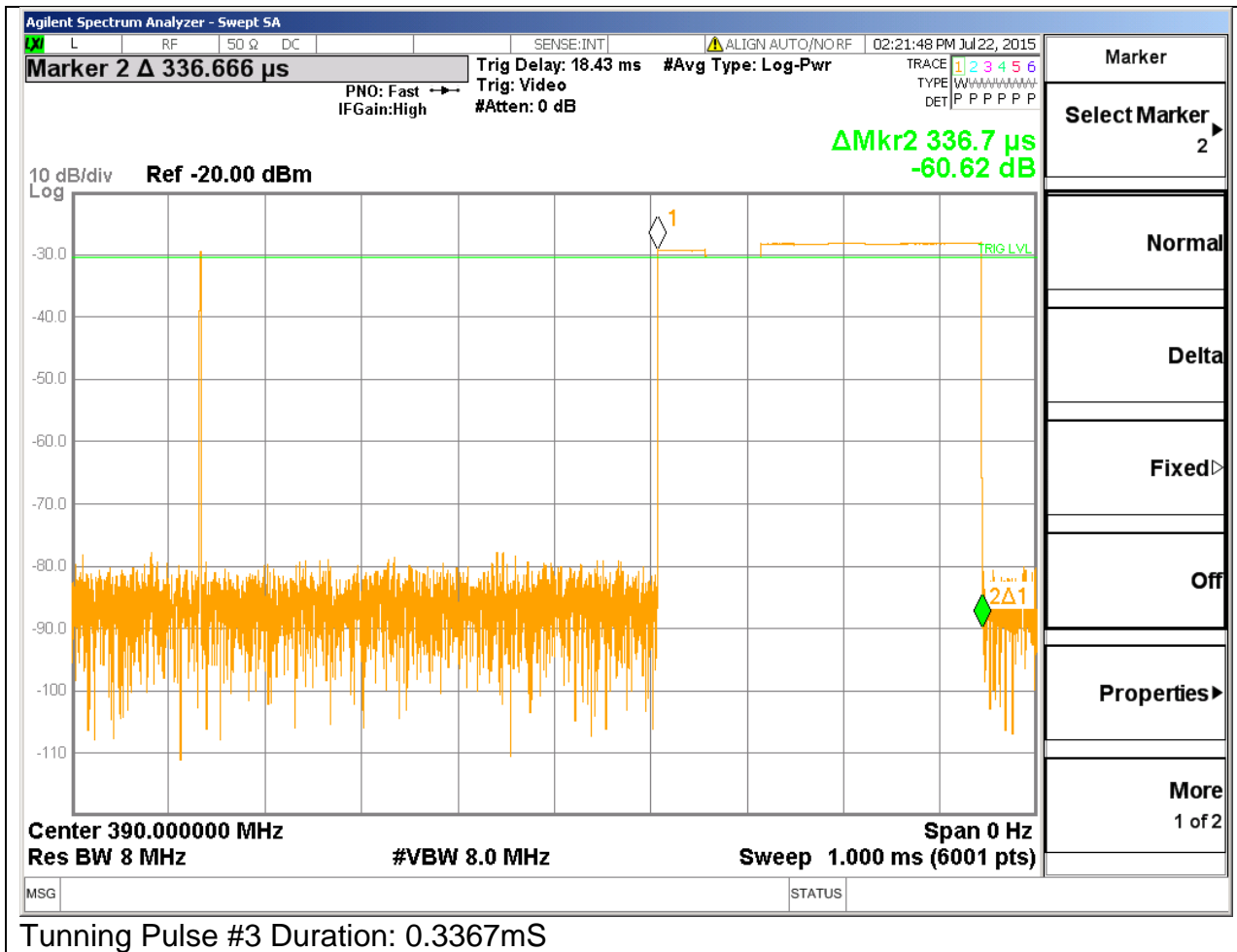
TX Frequency	Total TX time	Total Transmission period or 100ms whichever is lesser	DC Correction Factor (dB)
			$20\log\left(\frac{PulseWidth}{Period}\right)$
390MHz	$(45 \times 0.1997) + (33 \times 0.3997) = 22.68mS$	100mS	-12.88dB
Worst Case Duty Cycle: Worst case duty cycle was calculated over 100mS including the tuning pulses. The manufacturer declared duty cycle as -12.36dB, declared duty cycle is used for all radiated emissions data.			

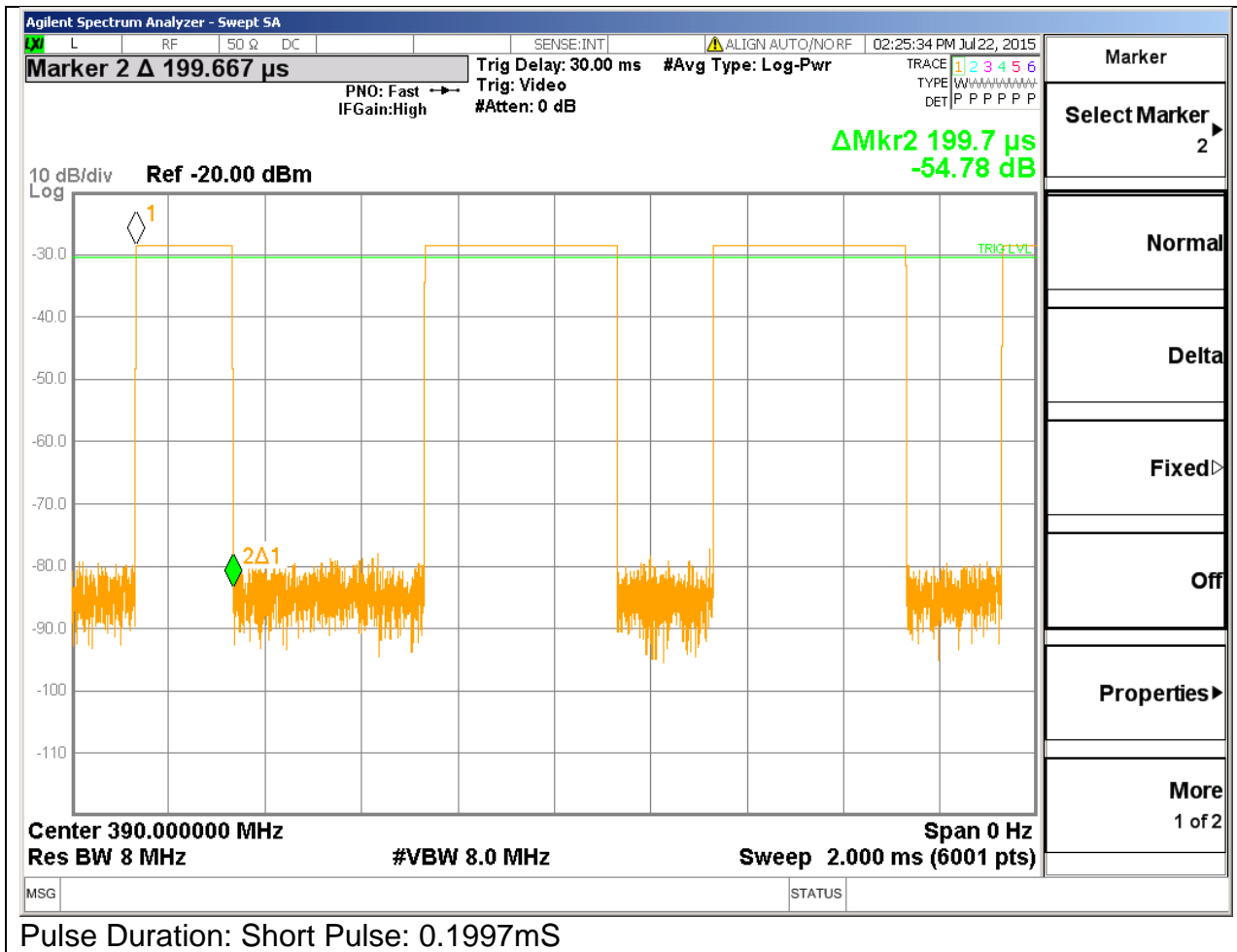
Figure 10 Pulse Train Graphs for 390MHz

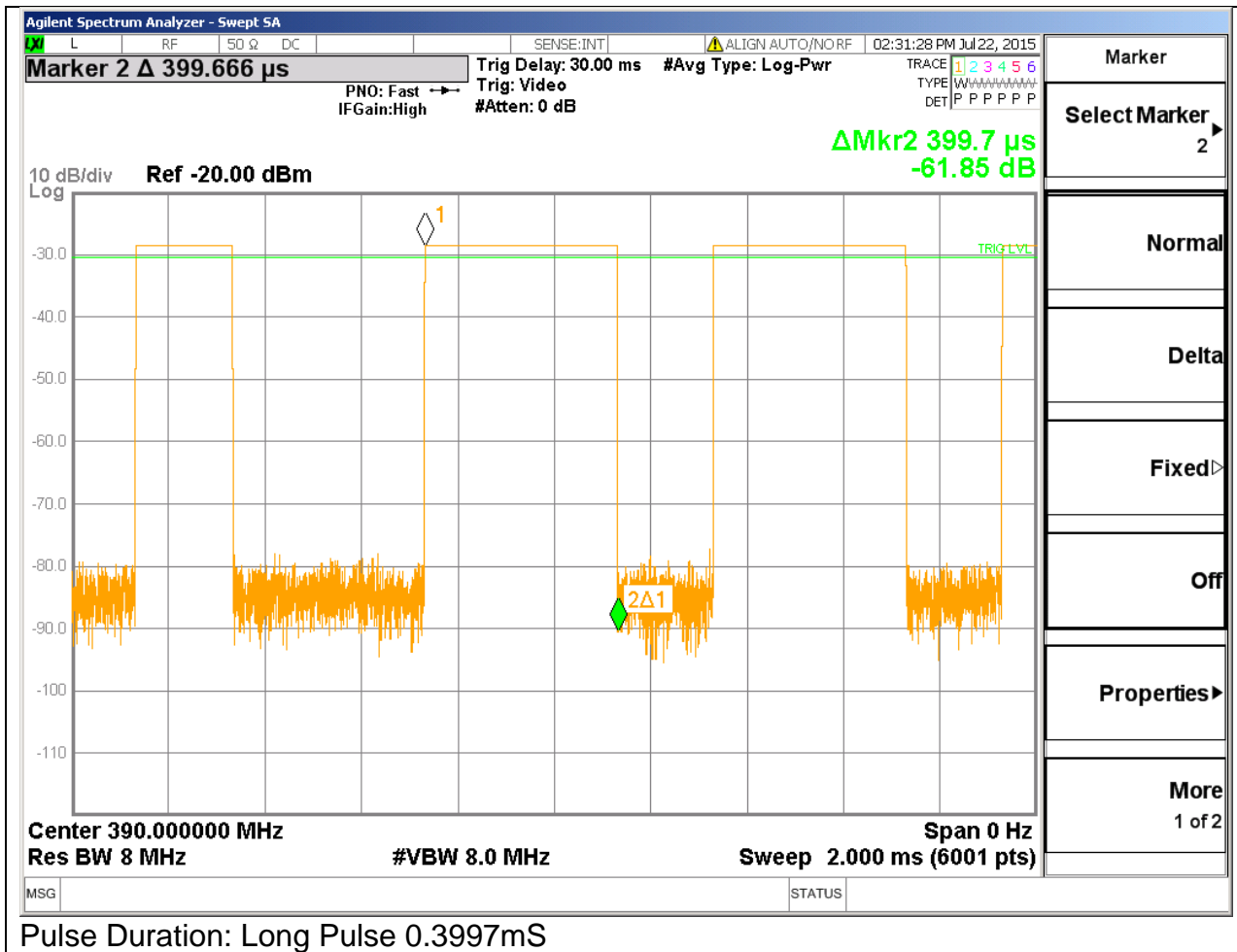


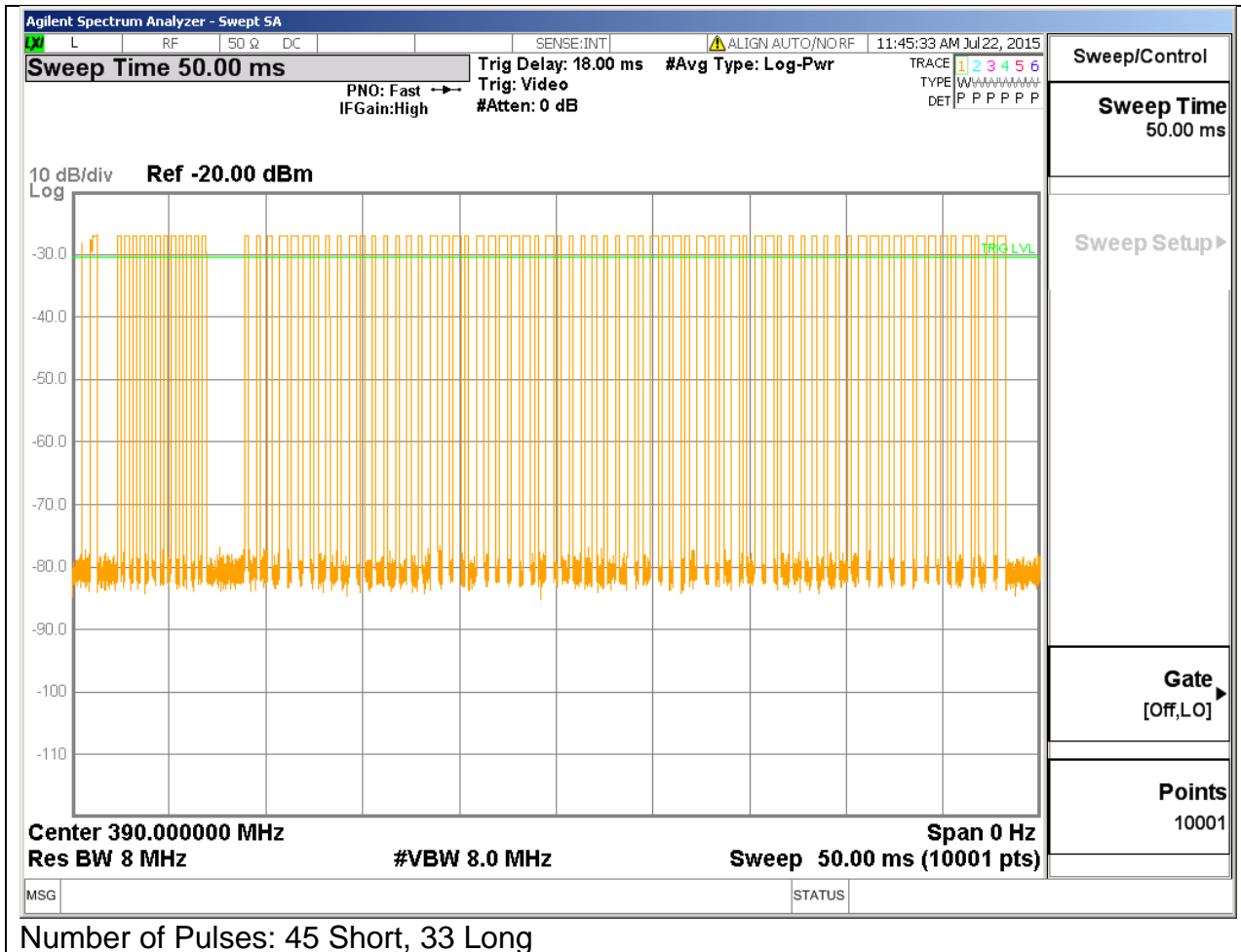
Tuning Pulse #1 duration: 0.1683mS

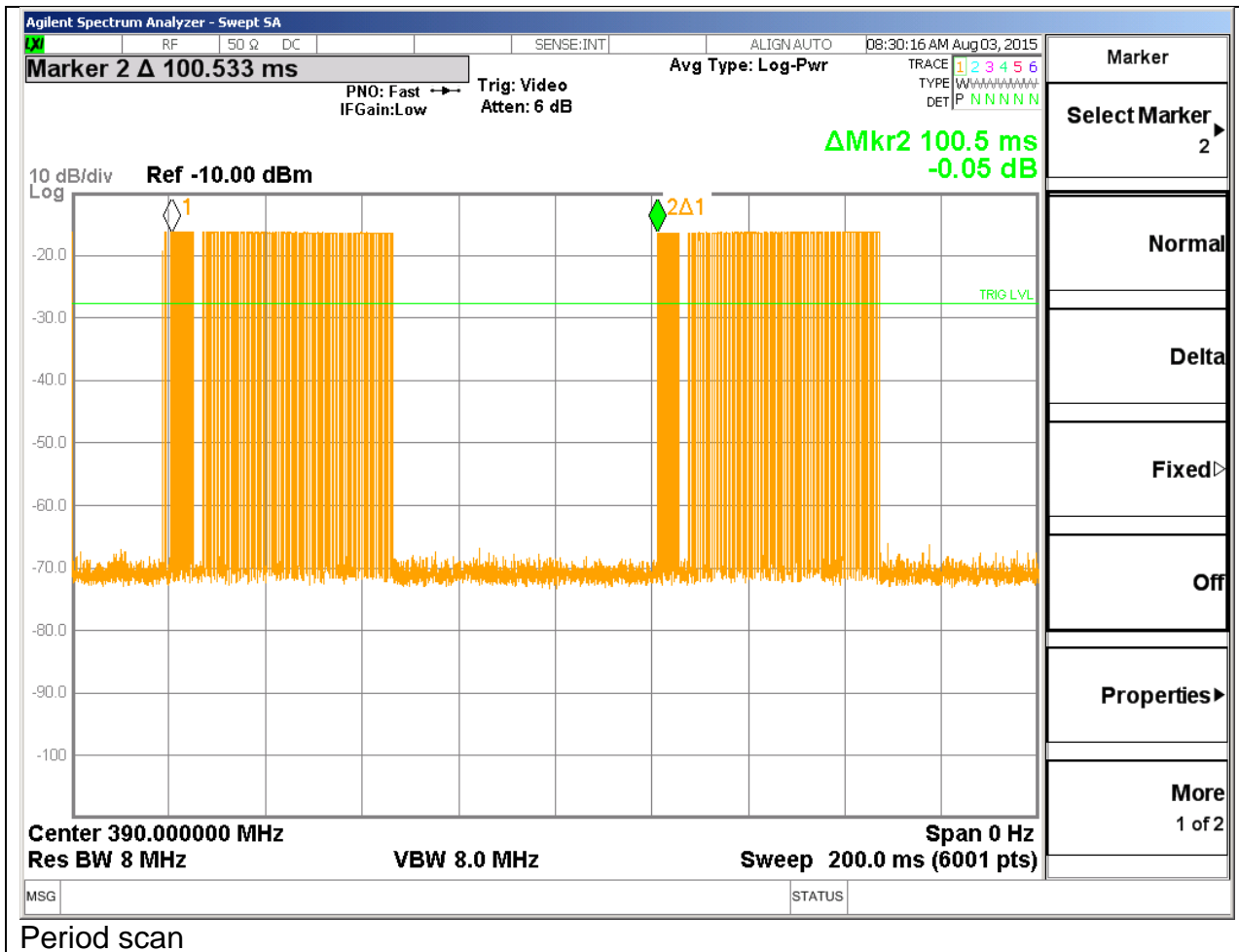








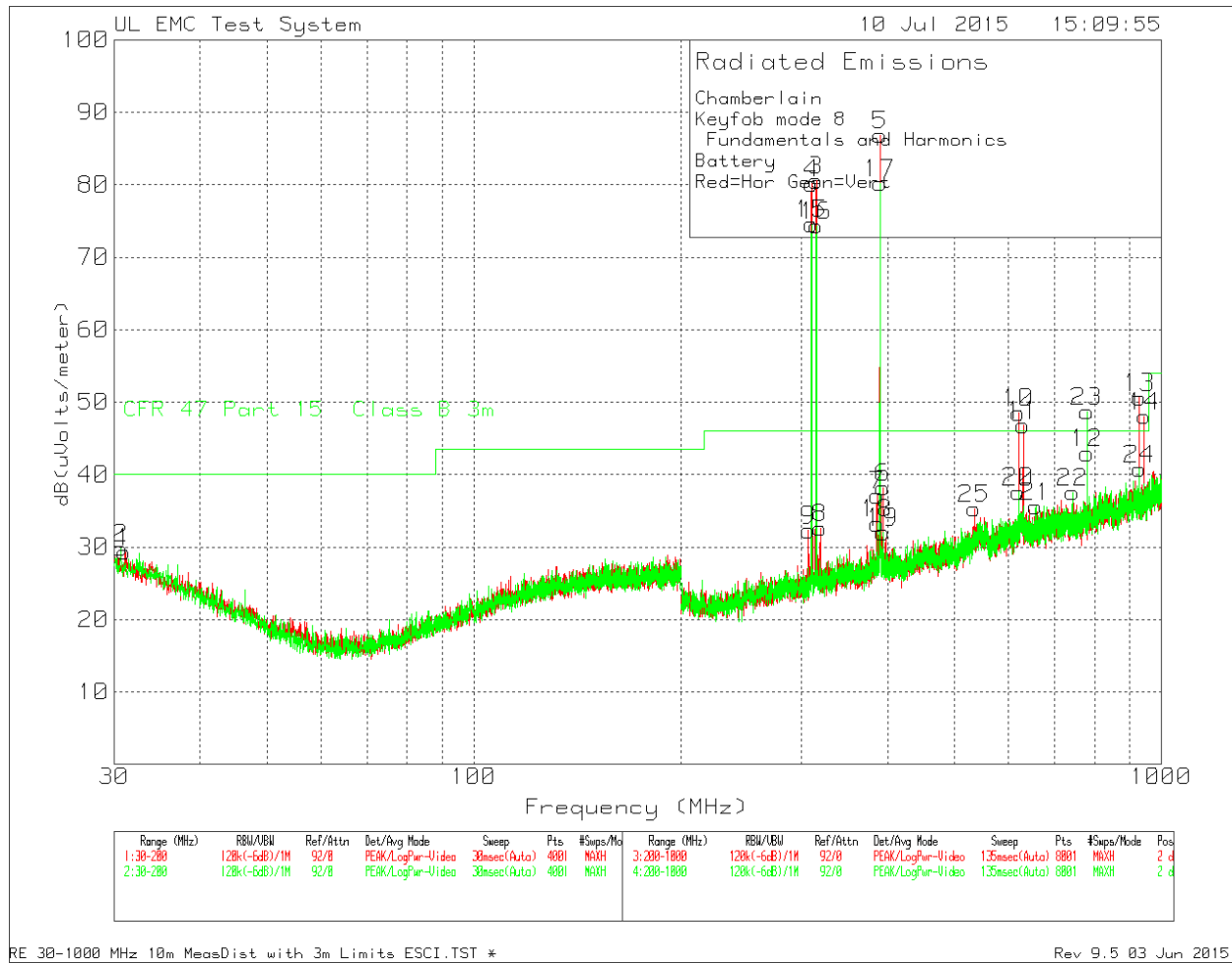




4.2.4 Test Conditions and Results – RADIATED EMISSIONS Fundamental and Spurious

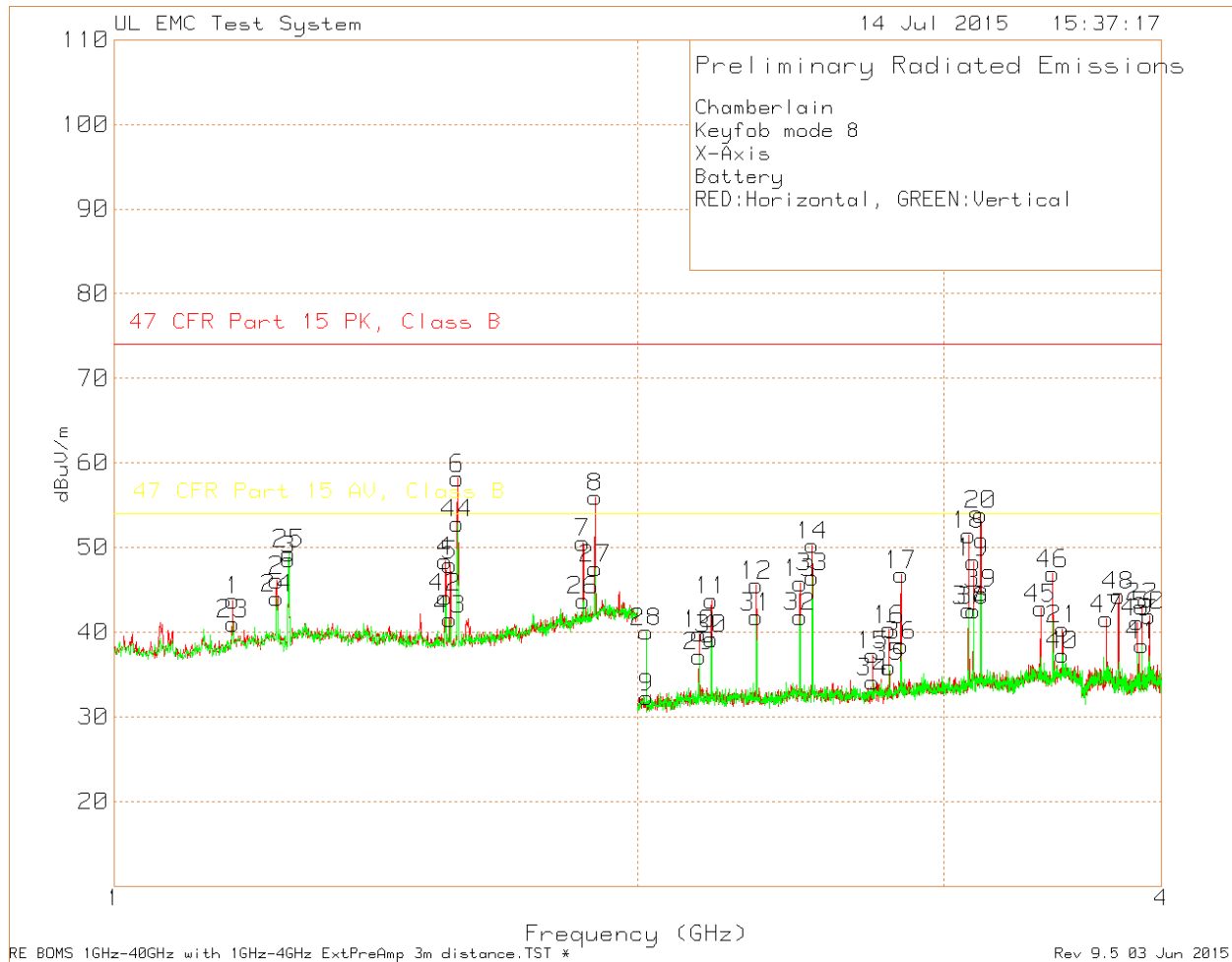
Test Description	Measurements were made in a 10-meter semi-anechoic chamber that complies to CISPR 16/ANSI C63.10:2009. Preliminary (peak) measurements were performed at an antenna to EUT separation distance of 3-meter as noted. The EUT was rotated 360° about its azimuth with the receive antenna located at various heights in both horizontal and vertical polarities. Final measurements (quasi-peak or average as noted) were then performed by rotating the EUT 360° and adjusting the receive antenna height from 1 to 4-meters. All frequencies were investigated in both horizontal and vertical antenna polarity, where applicable.	
Basic Standard	47 CFR Part 15 subpart C, and RSS-210	
UL LPG	80-EM-S0029	
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	30MHz – 1GHz	3 meter distance
	1GHz – 4GHz	3 meter distance
Out of band spurious emissions limit		
Frequency (MHz)	Limit (dB μ V/m)	
	Quasi-Peak	Peak
30 - 88	40.00	NA
88 - 216	43.52	NA
216 - 960	46.02	NA
960 - 1000	54	NA
Above 1000 (FCC)	NA	54 (at 3-meter)
Fundamental Frequency Limits and Non-restricted band Harmonic Limits		
Frequency (MHz)	Limit (dB μ V/m) @ 3m distance All harmonics except those in restricted bands must be attenuated by 20dB or more	
	Average - Fundamental	Peak - Fundamental
390	79.24	99.24
Supplementary information: See section 4.2.3 for duty cycle information.		

Figure 11 Radiated Emissions Graph (Below 1GHz)



Above scan is for mode #8. Mode #8 uses the same frequencies as mode #2 with few additional frequencies. The drive level for mode #8 is higher than drive for mode #2 therefore conducting a scan with mode #8 was considered as worst case.

Figure 12 Radiated Emissions Graph (Above 1GHz)



Above scan is for mode #8. Mode #8 uses the same frequencies as mode #1 with few additional ones. The drive level for mode #8 is higher than drive for mode #1 therefore conducting a scan with mode #8 was considered as worst case.

Table 15 - Radiated Emissions Data Points below 1GHz

Test Frequency (MHz)	Meter Reading (dBuV)	Detector	Antenna Factor dB/m	Path Factor dB	Peak Level dBuV/m	DC Factor dB	Average Level with DC dBuV/m	Peak Limit dBuV/m	Peak Margin dB	Average Limit dBuV/m	Average Margin dB	Azimuth [Degs]	Height [cm]	Polarity	Notes
390.0149	62.51	Pk	16.2	8.4	87.11	-12.36	74.75	99.24	-12.13	79.24	-4.49	312	101	H	1
390.0149	41.27	Pk	16.2	8.4	65.87	-12.36	53.51	99.24	-33.37	79.24	-25.73	268	108	V	1
390.02	56.39	Pk	16.2	8.4	80.99	-12.36	68.63	99.24	-18.25	79.24	-10.61	38	183	H	2
390.016	61.77	Pk	16.2	8.4	86.37	-12.36	74.01	99.24	-12.87	79.24	-5.23	147	155	V	2
390.018	56.16	Pk	16.2	8.4	80.76	-12.36	68.4	99.24	-18.48	79.24	-10.84	34	181	H	3
390.017	62.02	Pk	16.2	8.4	86.62	-12.36	74.26	99.24	-12.62	79.24	-4.98	41	180	H	3
780.024	17.02	Pk	21.8	9.9	48.72	-12.36	36.36	66.02	-17.3	46.02	-9.66	3	248	V	1
780.018	9.71	Pk	21.8	9.9	41.41	-12.36	29.05	66.02	-24.61	46.02	-16.97	308	114	H	1
780.026	8.65	Pk	21.8	9.9	40.35	-12.36	27.99	66.02	-25.67	46.02	-18.03	309	101	H	2
780.034	14.25	Pk	21.8	9.9	45.95	-12.36	33.59	66.02	-20.07	46.02	-12.43	226	157	V	2
780.045	19.32	Pk	21.8	9.9	51.02	-12.36	38.66	66.02	-15	46.02	-7.36	262	208	V	3
780.02	8.87	Pk	21.8	9.9	40.57	-12.36	28.21	66.02	-25.45	46.02	-17.81	198	108	H	3
Notes:															
1 - X- Axis (Laying Flat)															
2 - Z- Axis (Straight Up)															
3 - Y- Axis (Sideways)															
Pk - Peak detector															

Below 1GHz all measurement data was collected with transmitter set to mode #2 and duty cycle for mode #2.

Table 16 - Radiated Emissions Data Points above 1GHz

Marker No.	Test Frequency (GHz)	Meter Reading (dBuV)	Detector	Antenna Factor dB/m	Path Factor dB	Peak Level dBuV/m	DC Factor dB	Average Level with DB dBuV/m	Peak Limit dBuV/m	Peak Margin dB	Average Limit dBuV/m	Average Margin dB	Azimuth [Degs]	Height [cm]	Polarity
1	1.17	71.9	Pk	28.2	-56.34	43.76	-12.36	31.4	74	-30.24	54	-22.6	0-360	100	H
23	1.17	69.11	Pk	28.2	-56.34	40.97	-12.36	28.61	74	-33.03	54	-25.39	0-360	150	V
5	1.56	74.56	Pk	28.2	-54.85	47.91	-12.36	35.55	74	-26.09	54	-18.45	0-360	150	H
43	1.56	68.17	Pk	28.2	-54.85	41.52	-12.36	29.16	74	-32.48	54	-24.84	0-360	150	V
12	2.34	75.69	Pk	21.7	-51.87	45.52	-12.36	33.16	74	-28.48	54	-20.84	0-360	99	H
31	2.34	71.95	Pk	21.7	-51.87	41.78	-12.36	29.42	74	-32.22	54	-24.58	0-360	100	V
15	2.73	66.52	Pk	22.1	-51.31	37.31	-12.36	24.95	74	-36.69	54	-29.05	0-360	99	H
34	2.73	63.34	Pk	22.1	-51.31	34.13	-12.36	21.77	74	-39.87	54	-32.23	0-360	150	V
19	3.12	76.16	Pk	22.7	-50.61	48.25	-12.36	35.89	74	-25.75	54	-18.11	0-360	99	H
38	3.12	70.44	Pk	22.7	-50.61	42.53	-12.36	30.17	74	-31.47	54	-23.83	0-360	100	V
21	3.51	66.84	Pk	23.5	-49.96	40.38	-12.36	28.02	74	-33.62	54	-25.98	0-360	99	H
40	3.51	63.76	Pk	23.5	-49.96	37.3	-12.36	24.94	74	-36.7	54	-29.06	0-360	100	V
22	3.901	70.59	Pk	23.8	-51.38	43.01	-12.36	30.65	74	-30.99	54	-23.35	0-360	150	H
41	3.901	66.02	Pk	23.8	-51.38	38.44	-12.36	26.08	74	-35.56	54	-27.92	0-360	100	V
9	2.024	64.39	Pk	21.2	-53.29	32.3	0	-	74	-41.7	54	-21.7	0-360	150	H
45	3.41	69.97	Pk	23.5	-50.66	42.81	0	-	74	-31.19	54	-11.19	0-360	99	H
46	3.465	74.39	Pk	23.5	-50.99	46.9	0	-	74	-27.1	54	-7.1	0-360	99	H
47	3.721	67.86	Pk	23.6	-49.9	41.56	0	-	74	-32.44	54	-12.44	0-360	150	H
48	3.781	71.77	Pk	24	-51.46	44.31	0	-	74	-29.69	54	-9.69	0-360	150	H
49	3.876	68.41	Pk	23.9	-51.15	41.16	0	-	74	-32.84	54	-12.84	0-360	150	H
50	3.938	68.86	Pk	24	-50.95	41.91	0	-	74	-32.09	54	-12.09	0-360	99	H
28	2.023	72.09	Pk	21.2	-53.27	40.02	0	-	74	-33.98	54	-13.98	0-360	150	V
Pk - Peak detector															

For above 1GHz all measurement data was collected with transmitter set to mode #8 (higher output power) and duty cycle from mode #2. Because all emission levels are under the limit it was considered worst case and it was considered not necessary to re-do measurement with transmitter set to mode #2.

4.3 Mode#3 Test Data

4.3.1 Test Conditions and Results – Occupied Bandwidth

Test Description	Measurements were made in the laboratory environment. A Dipole (or equivalent) antenna tuned to the transmit frequency was attached to the input of a spectrum analyzer. The device was operated and the spectrum analyzer resolution bandwidth set per the appropriate standard.	
Basic Standard	47 CFR Part 15.231(c)	
Occupied Bandwidth Limits		
0.25% of Center Frequency (318MHz: 795kHz)		

Table 17 Occupied Bandwidth Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	1	1
Supplementary information: None		

Table 18 Occupied Bandwidth Spectrum Analyzer Settings

Resolution Bandwidth	Occupied Bandwidth Requirements	
	dBc	% PWR
10kHz	-20	99
Supplementary information: None		

Table 19 Occupied Bandwidth Test Result Summary

Center Frequency	20dB BW Measured (kHz)	99% BW Measured (kHz)
318MHz	14.7	27.18

Figure 13 – 20dB Bandwidth Graph 318MHz

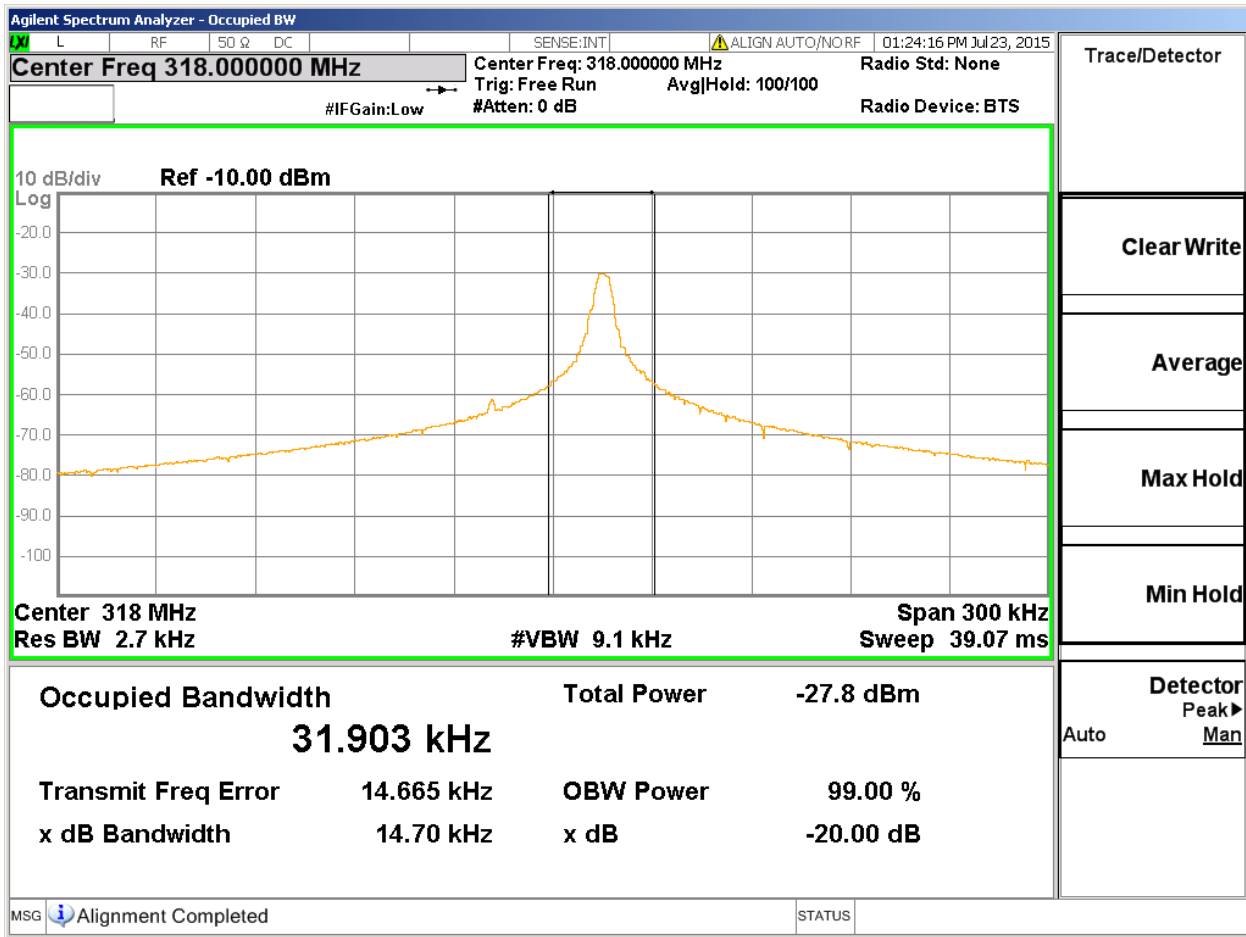
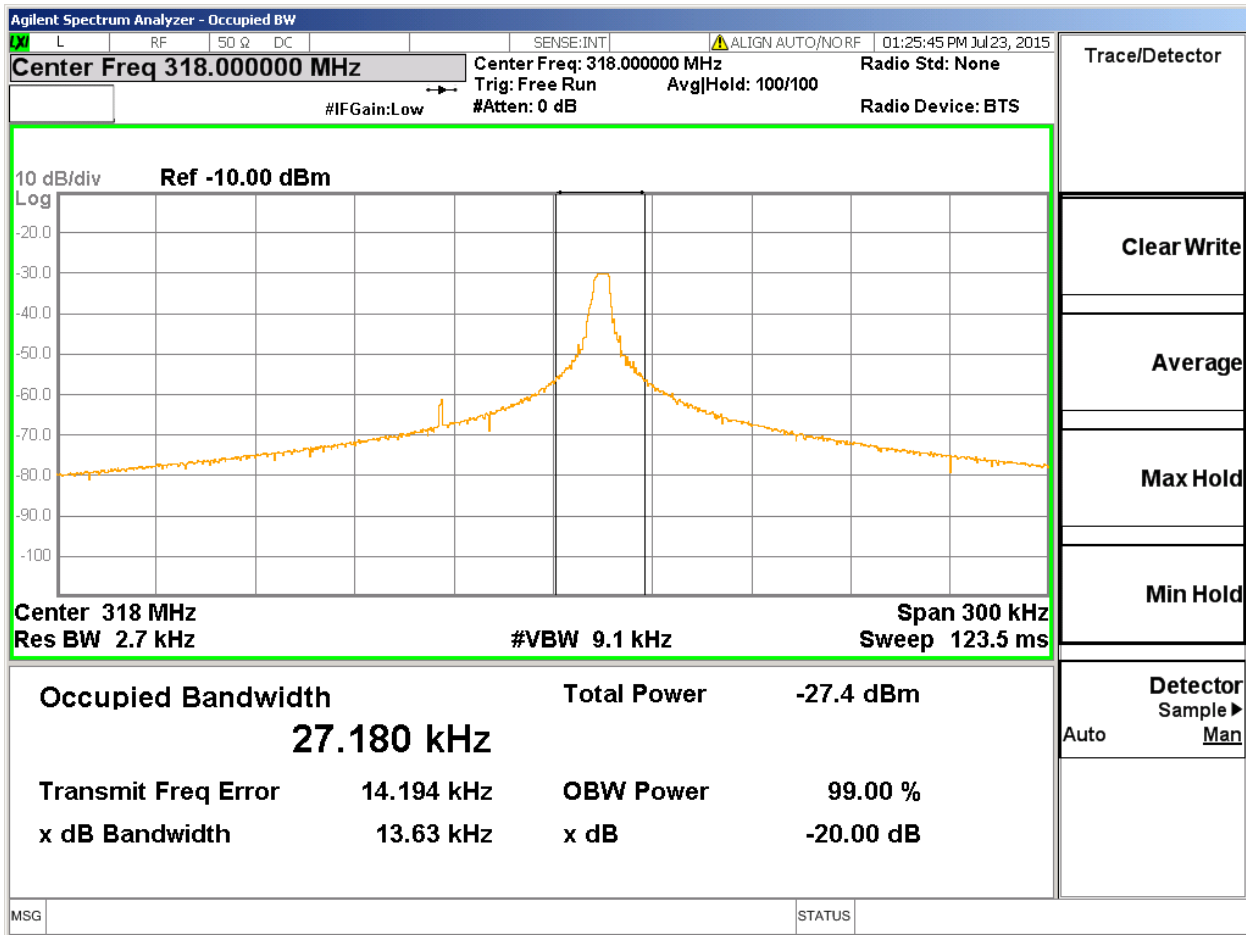


Figure 14 – 99% Bandwidth Graph 318MHz



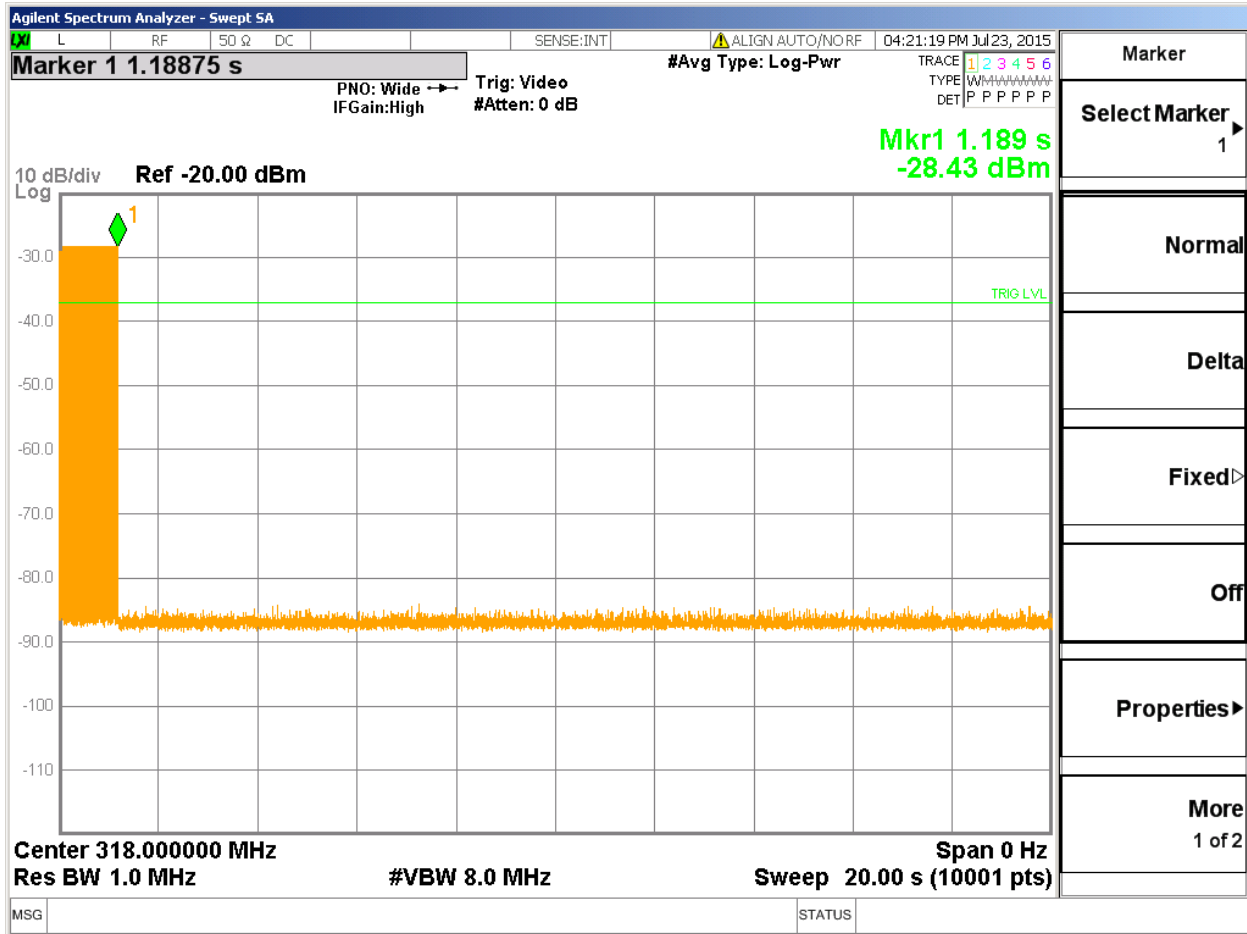
4.3.2 Test Conditions and Results – Cease Operation

Test Description	Measurements were made in the laboratory environment. A Dipole (or equivalent) antenna tuned to the transmit frequency was attached to the input of a spectrum analyzer. The device was operated and the transmission time measured with the spectrum analyzer set to zero span at the fundamental frequency.	
Basic Standard	47 CFR Part 15.231(a)	
Cease Operation Limits		
The transmissions shall stop within 5 seconds of either a button being released or if automatically controlled transmissions shall be stopped 5 seconds after transmissions begin.		

Table 20 Cease Operation Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	1	1
Supplementary information: None		

Figure 15 Cease Operation Graph 318MHz



4.3.3 Test Conditions and Results – Pulse Train

Test Description	Measurements were made in the laboratory environment. A Dipole (or equivalent) antenna tuned to the transmit frequency was attached to the input of a spectrum analyzer. The pulse train was measured with the spectrum analyzer set to zero span at the fundamental frequency.	
Basic Standard	FCC Part 15 Subpart A, 15.35	
Pulse Train Limits		
There are no limits for this test. This data is used to calculate the averaging correction factor that is applied to the measured peak radiated emissions results.		

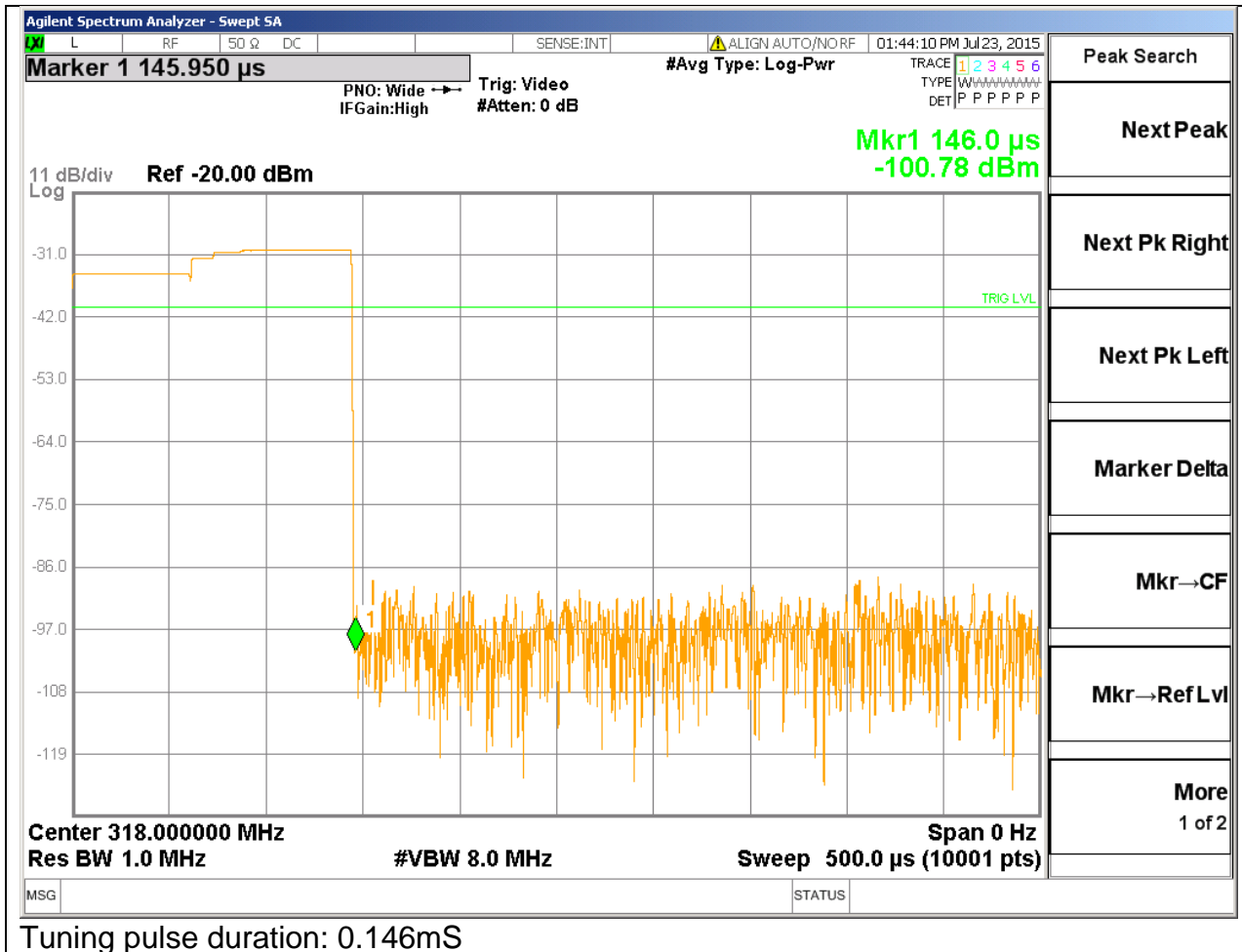
Table 21 Pulse Train Configuration Settings

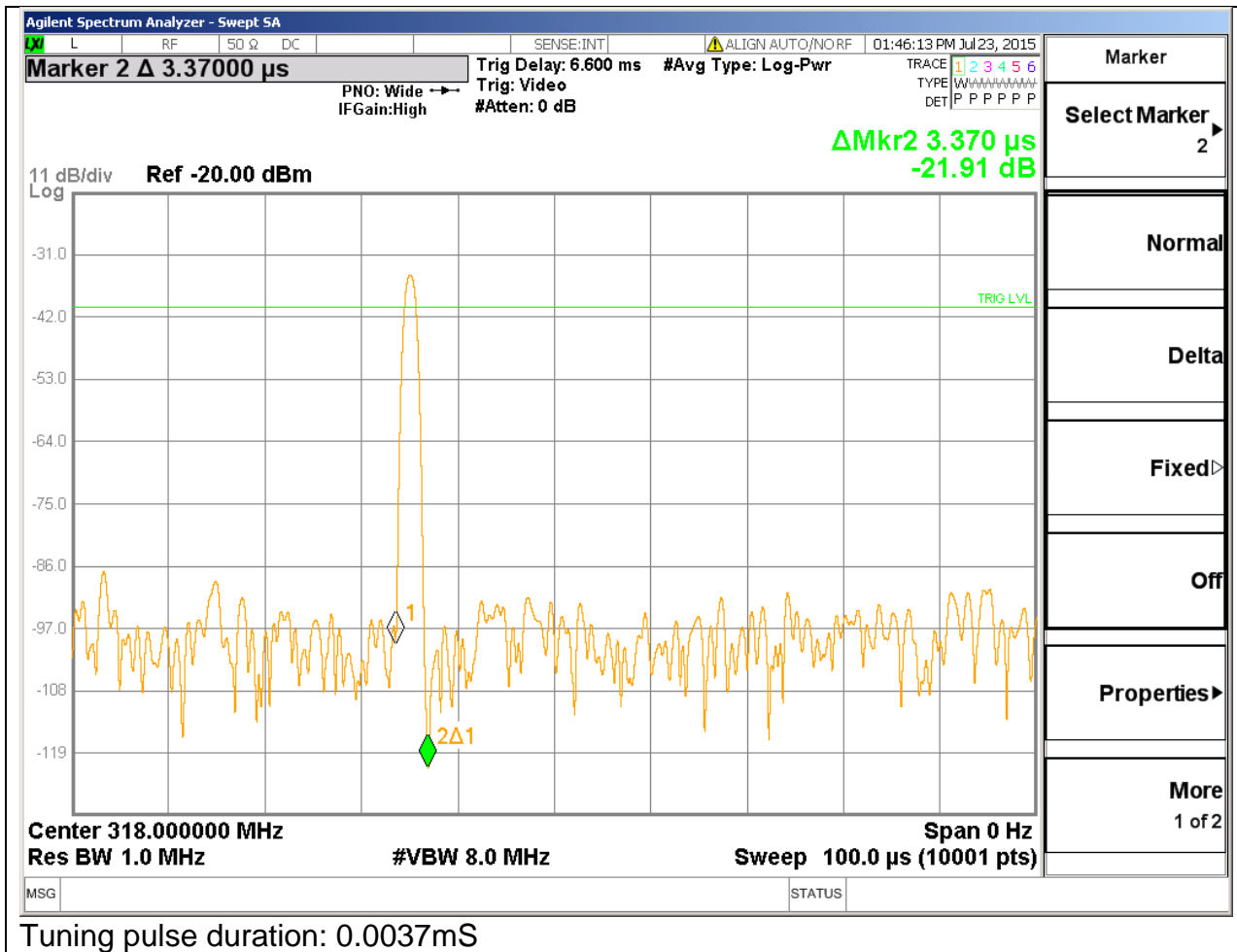
Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	1	1
Supplementary information: None		

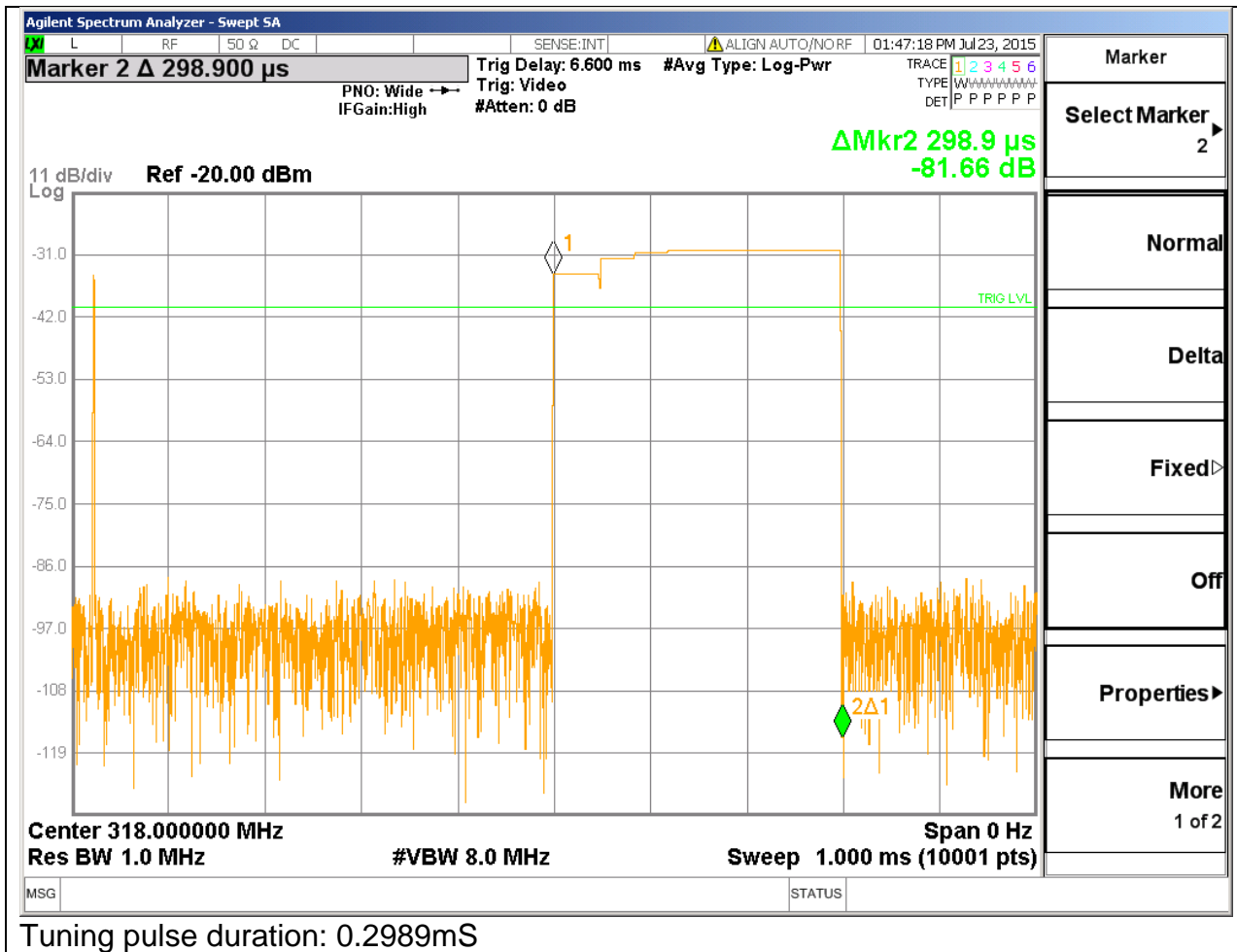
Table 22 Pulse Train Calculation

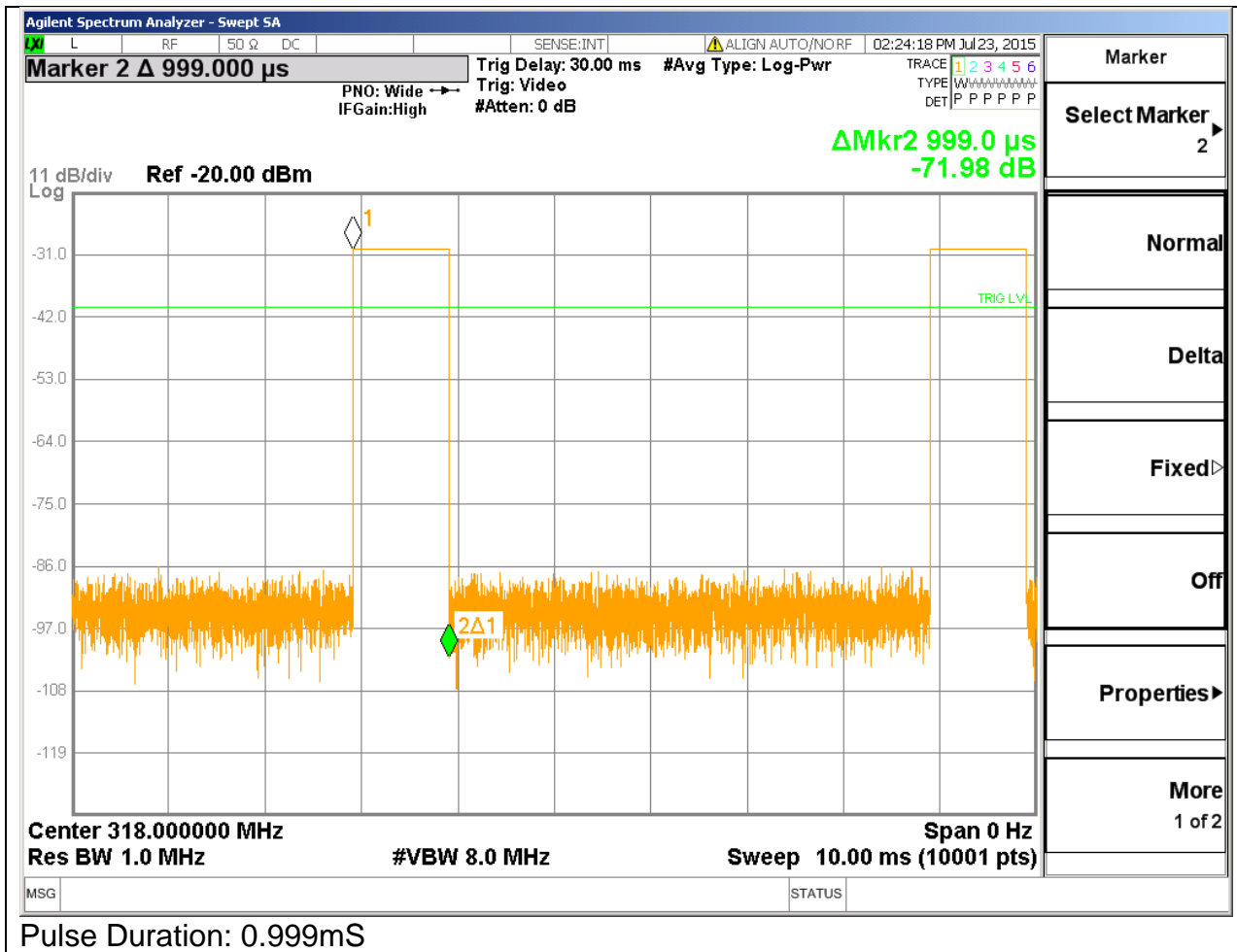
TX Frequency	Total TX time	Total Transmission period or 100ms whichever is lesser	DC Correction Factor (dB)
			$20\log\left(\frac{PulseWidth}{Period}\right)$
318MHz	16x0.999mS	15.984mS	-15.93dB
Worst Case Duty Cycle: Worst case duty cycle was calculated over 100mS. The manufacturer declared duty cycle as -15.39 and. Declared duty cycle is used for all radiated emissions data.			

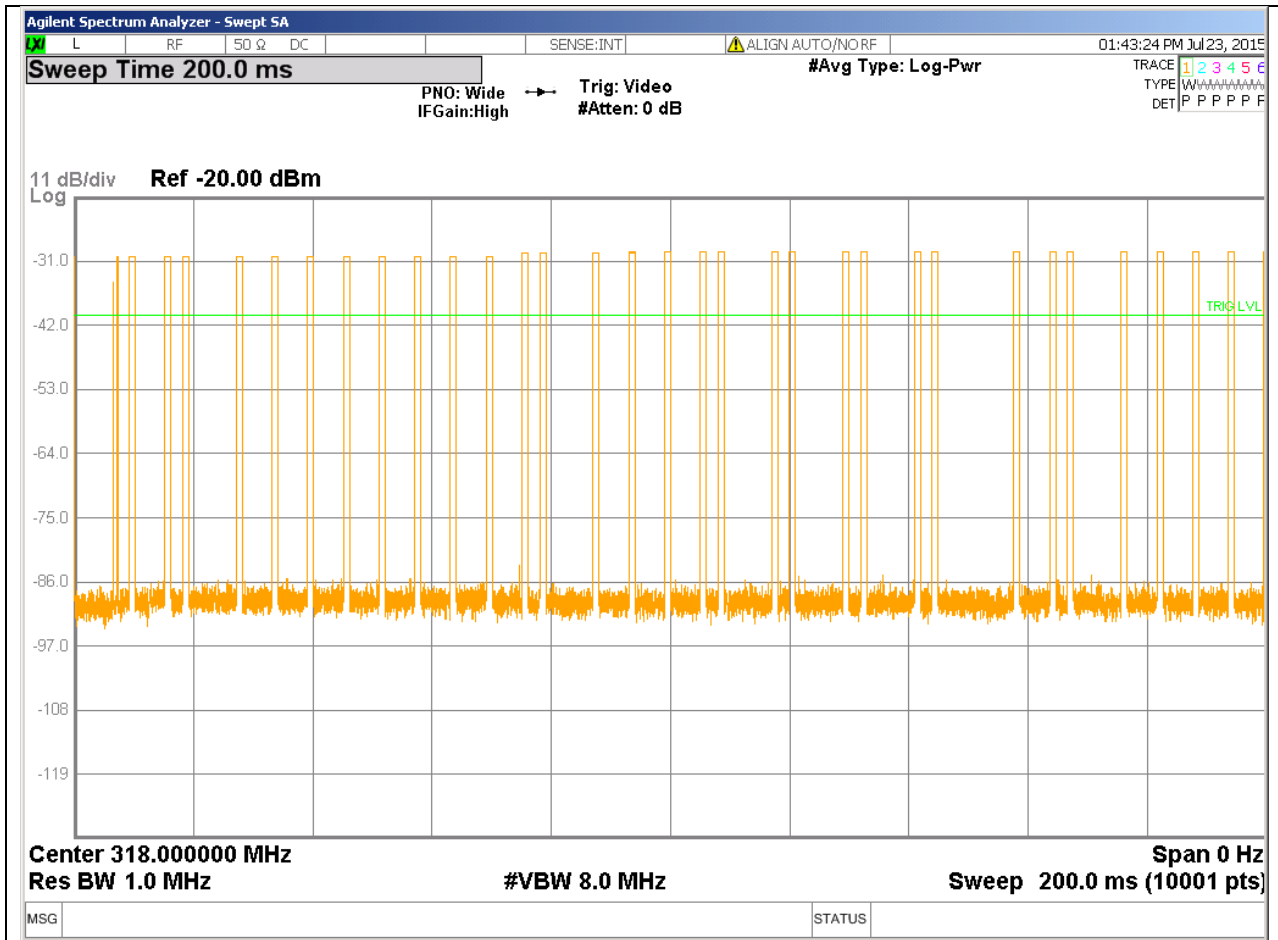
Figure 16 Pulse Train Graphs for 310MHz











Number of Pulses: 16 Pulses per 100mS



4.3.4 Test Conditions and Results – RADIATED EMISSIONS Fundamental and Spurious

Test Description	Measurements were made in a 10-meter semi-anechoic chamber that complies to CISPR 16/ANSI C63.10:2009. Preliminary (peak) measurements were performed at an antenna to EUT separation distance of 3-meter as noted. The EUT was rotated 360° about its azimuth with the receive antenna located at various heights in both horizontal and vertical polarities. Final measurements (quasi-peak or average as noted) were then performed by rotating the EUT 360° and adjusting the receive antenna height from 1 to 4-meters. All frequencies were investigated in both horizontal and vertical antenna polarity, where applicable.	
Basic Standard	47 CFR Part 15 subpart C, and RSS-210	
UL LPG	80-EM-S0029	
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	30MHz – 1GHz	3 meter distance
	1GHz – 4GHz	3 meter distance
Out of band spurious emissions limit		
Frequency (MHz)	Limit (dBµV/m)	
	Quasi-Peak	Peak
30 - 88	40.00	NA
88 - 216	43.52	NA
216 - 960	46.02	NA
960 - 1000	54	NA
Above 1000 (FCC)	NA	54 (at 3-meter)
Fundamental Frequency Limits and Non-restricted band Harmonic Limits		
Frequency (MHz)	Limit (dBµV/m) @ 3m distance All harmonics except those in restricted bands must be attenuated by 20dB or more	
	Average - Fundamental	Peak - Fundamental
318	75.80	95.80
Supplementary information: See section 4.3.3 for duty cycle information.		

Figure 17 Radiated Emissions Graph (Below 1GHz)

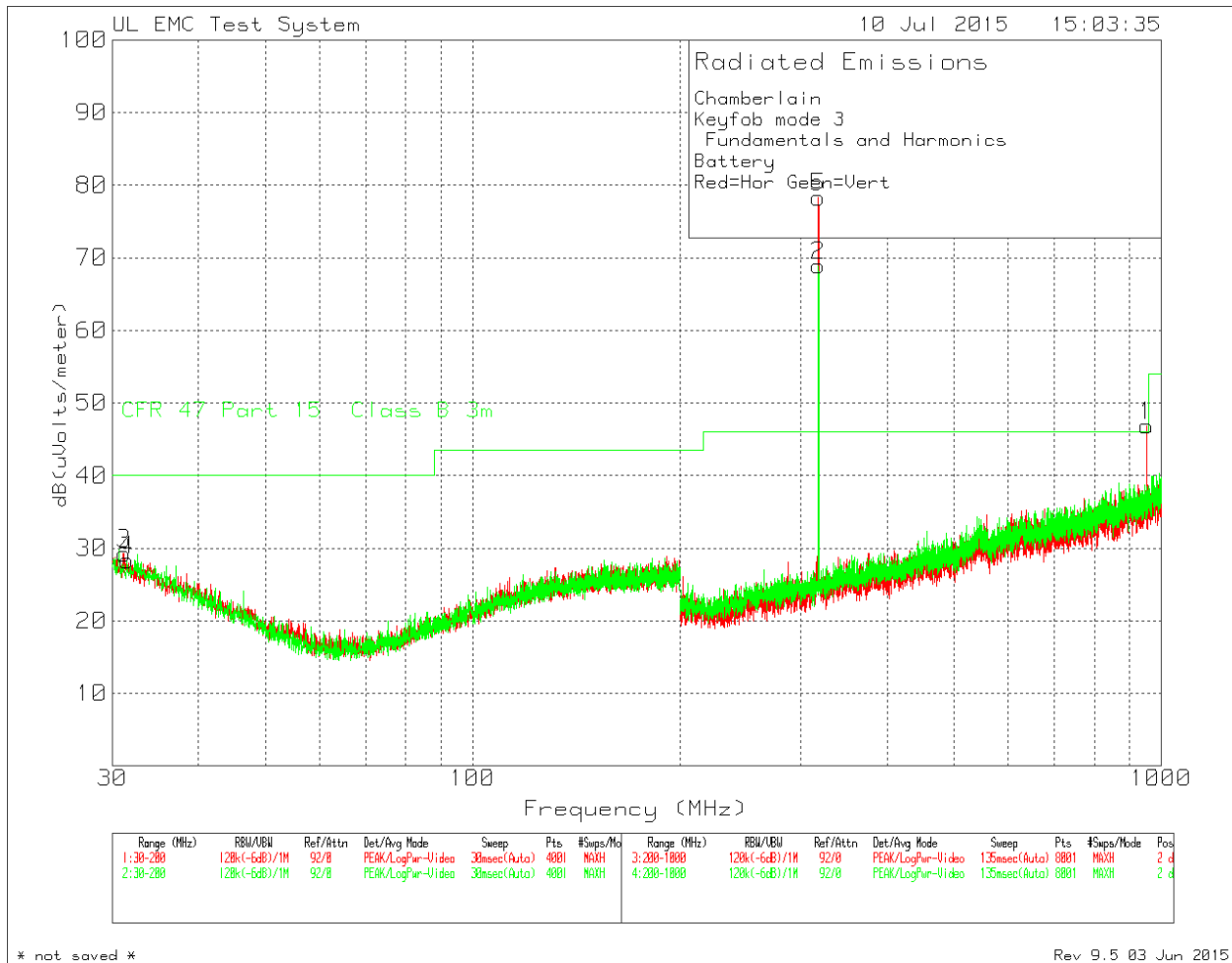


Figure 18 Radiated Emissions Graph Above 1GHz

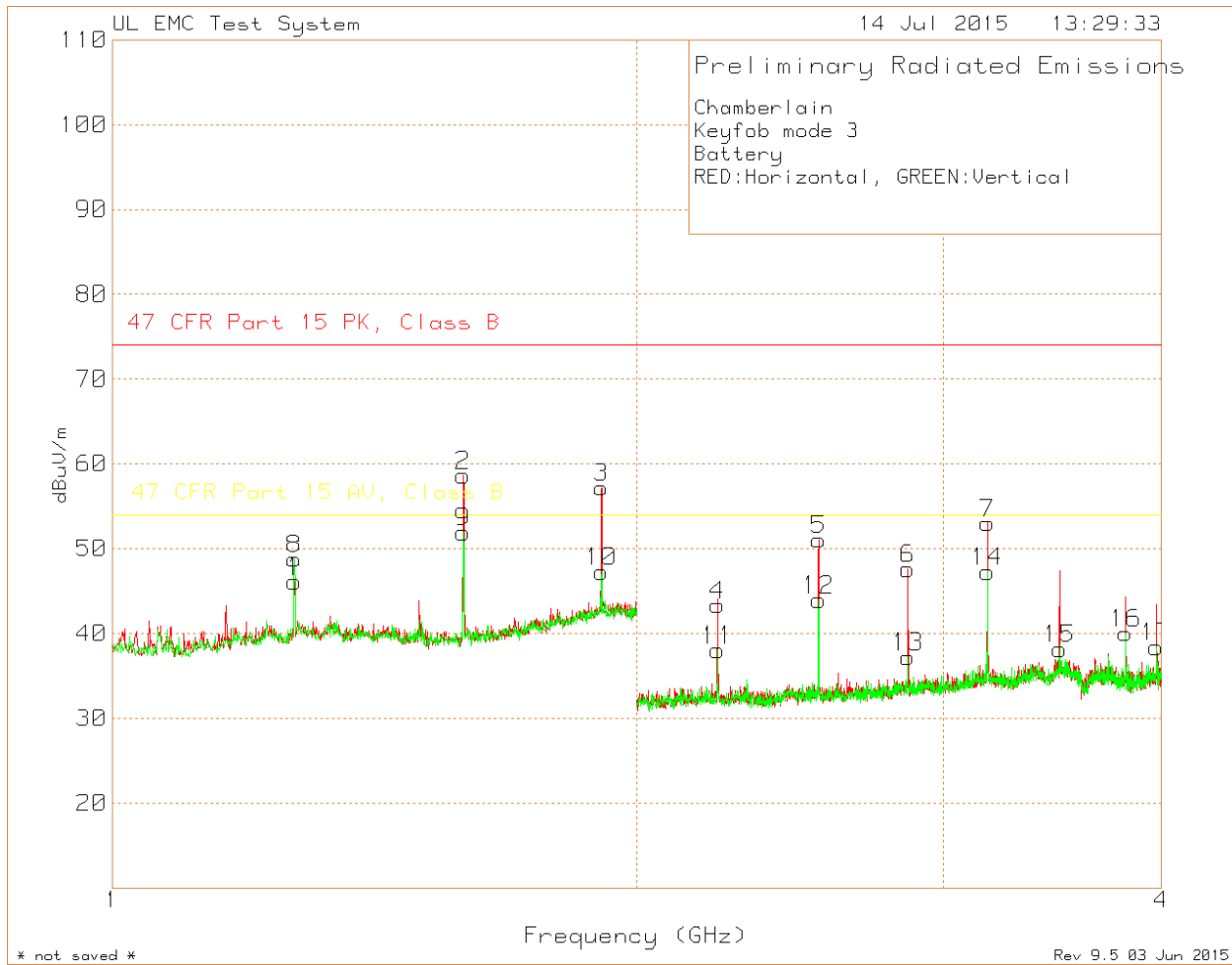


Table 23 - Radiated Emissions Data Points below 1GHz

Test Frequency (MHz)	Meter Reading (dBuV)	Detector	Antenna Factor dB/m	Path Factor dB	Level dBuV/m	DC Factor dB	Average Level with DC dBuV/m	Peak Limit dBuV/m	Peak Margin dB	Average Limit dBuV/m	Average Margin dB	Azimuth [Degs]	Height [cm]	Polarity	Notes
318.022	61.37	Pk	14.5	8.1	83.97	-15.39	68.58	95.8	-11.83	75.8	-7.22	315	101	H	1
318.02	45.47	Pk	14.5	8.1	68.07	-15.39	52.68	95.8	-27.73	75.8	-23.12	332	171	V	1
636.03	8.16	Pk	20.8	9.2	38.16	-15.39	22.77	66.02	-27.86	46.02	-23.25	79	101	V	1
636.061	12.46	Pk	20.8	9.2	42.46	-15.39	27.07	66.02	-23.56	46.02	-18.95	60	146	H	1
954.051	9.22	Pk	24	10.4	43.62	-15.39	28.23	66.02	-22.4	46.02	-17.79	288	114	V	1
954.052	13.69	Pk	24	10.4	48.09	-15.39	32.7	66.02	-17.93	46.02	-13.32	186	101	H	1
318.02	58.21	Pk	14.5	8.1	80.81	-15.39	65.42	95.8	-14.99	75.8	-10.38	86	200	V	2
318.021	54.08	Pk	14.5	8.1	76.68	-15.39	61.29	95.8	-19.12	75.8	-14.51	172	237	H	2
636.042	8.85	Pk	20.8	9.2	38.85	-15.39	23.46	66.02	-27.17	46.02	-22.56	101	103	V	2
636.033	11.39	Pk	20.8	9.2	41.39	-15.39	26	66.02	-24.63	46.02	-20.02	30	142	H	2
954.059	13.71	Pk	24	10.4	48.11	-15.39	32.72	66.02	-17.91	46.02	-13.3	324	126	V	2
954.056	8.86	Pk	24	10.4	43.26	-15.39	27.87	66.02	-22.76	46.02	-18.15	192	151	H	2
318.018	54.61	Pk	14.5	8.1	77.21	-15.39	61.82	95.8	-18.59	75.8	-13.98	177	245	H	3
318.019	57.87	Pk	14.5	8.1	80.47	-15.39	65.08	95.8	-15.33	75.8	-10.72	90	198	V	3
636.039	8.44	Pk	20.8	9.2	38.44	-15.39	23.05	66.02	-27.58	46.02	-22.97	111	129	H	3
636.038	11.86	Pk	20.8	9.2	41.86	-15.39	26.47	66.02	-24.16	46.02	-19.55	152	103	V	3
954.051	12.8	Pk	24	10.4	47.2	-15.39	31.81	66.02	-18.82	46.02	-14.21	24	156	H	3
954.049	12.58	Pk	24	10.4	46.98	-15.39	31.59	66.02	-19.04	46.02	-14.43	90	122	V	3
Notes:															
1 - X-Axis Program 3, 318MHz															
2 - Y-Axis Program 3, 318MHz															
3 - Z-Axis Program 3, 318MHz															
PK - Peak detector															

Table 24 - Radiated Emissions Data Points above 1GHz

Marker No.	Test Frequency (GHz)	Meter Reading (dBuV)	Detector	Antenna Factor dB/m	Path Factor dB	Level dBuV/m	DC Factor dB	Average Level with DC dBuV/m	Peak Limit dBuV/m	Peak Margin dB	Average Limit dBuV/m	Average Margin dB	Azimuth [Degs]	Height [cm]	Polarity
1	1.272	72.97	Pk	29	-55.86	46.11	-15.39	30.72	74	-27.89	54	-23.28	0-360	100	H
2	1.59	86.43	Pk	28.2	-54.49	60.14	-15.39	44.75	74	-13.86	54	-9.25	27	111	H
3	1.9082	79.8	Pk	31.5	-53.31	57.99	-15.39	42.6	74	-16.01	54	-11.4	93	120	H
4	2.225	74.01	Pk	21.8	-52.46	43.35	-15.39	27.96	74	-30.65	54	-26.04	0-360	100	H
5	2.5441	81.16	Pk	22.2	-51.76	51.6	-15.39	36.21	74	-22.4	54	-17.79	109	187	H
6	2.862	75.95	Pk	22.4	-50.75	47.6	-15.39	32.21	74	-26.4	54	-21.79	0-360	100	H
7	3.1802	80.51	Pk	23.1	-51.01	52.6	-15.39	37.21	74	-21.4	54	-16.79	139	119	H
8	1.272	75.64	Pk	29	-55.86	48.78	-15.39	33.39	74	-25.22	54	-20.61	0-360	150	V
9	1.59	79.04	Pk	28.2	-54.49	52.75	-15.39	37.36	74	-21.25	54	-16.64	109	150	V
10	1.909	69.09	Pk	31.5	-53.31	47.28	-15.39	31.89	74	-26.72	54	-22.11	0-360	150	V
11	2.226	68.67	Pk	21.8	-52.45	38.02	-15.39	22.63	74	-35.98	54	-31.37	0-360	99	V
12	2.544	73.49	Pk	22.2	-51.76	43.93	-15.39	28.54	74	-30.07	54	-25.46	0-360	150	V
13	2.862	65.56	Pk	22.4	-50.75	37.21	-15.39	21.82	74	-36.79	54	-32.18	0-360	99	V
14	3.18	75.21	Pk	23.1	-51.02	47.29	-15.39	31.9	74	-26.71	54	-22.1	0-360	99	V
15	3.499	64.75	Pk	23.5	-50.09	38.16	-15.39	22.77	74	-35.84	54	-31.23	0-360	150	V
16	3.817	67.37	Pk	24	-51.33	40.04	-15.39	24.65	74	-33.96	54	-29.35	0-360	150	V
17	3.976	65	Pk	24.3	-50.89	38.41	-15.39	23.02	74	-35.59	54	-30.98	0-360	99	V

Pk - Peak detector

4.4 Mode#4 Test Data

4.4.1 Test Conditions and Results – Occupied Bandwidth

Test Description	Measurements were made in the laboratory environment. A Dipole (or equivalent) antenna tuned to the transmit frequency was attached to the input of a spectrum analyzer. The device was operated and the spectrum analyzer resolution bandwidth set per the appropriate standard.	
Basic Standard	47 CFR Part 15.231(c)	
Occupied Bandwidth Limits		
0.25% of Center Frequency (390MHz: 975.00kHz)		

Table 25 Occupied Bandwidth Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	1	1
Supplementary information: None		

Table 26 Occupied Bandwidth Spectrum Analyzer Settings

Resolution Bandwidth	Occupied Bandwidth Requirements	
	dBc	% PWR
10kHz	-20	99
Supplementary information: None		

Table 27 Occupied Bandwidth Test Result Summary

Center Frequency	20dB BW Measured (kHz)	99% BW Measured (kHz)
390MHz	19.99	38.133

Figure 19 – 20dB Bandwidth Graph

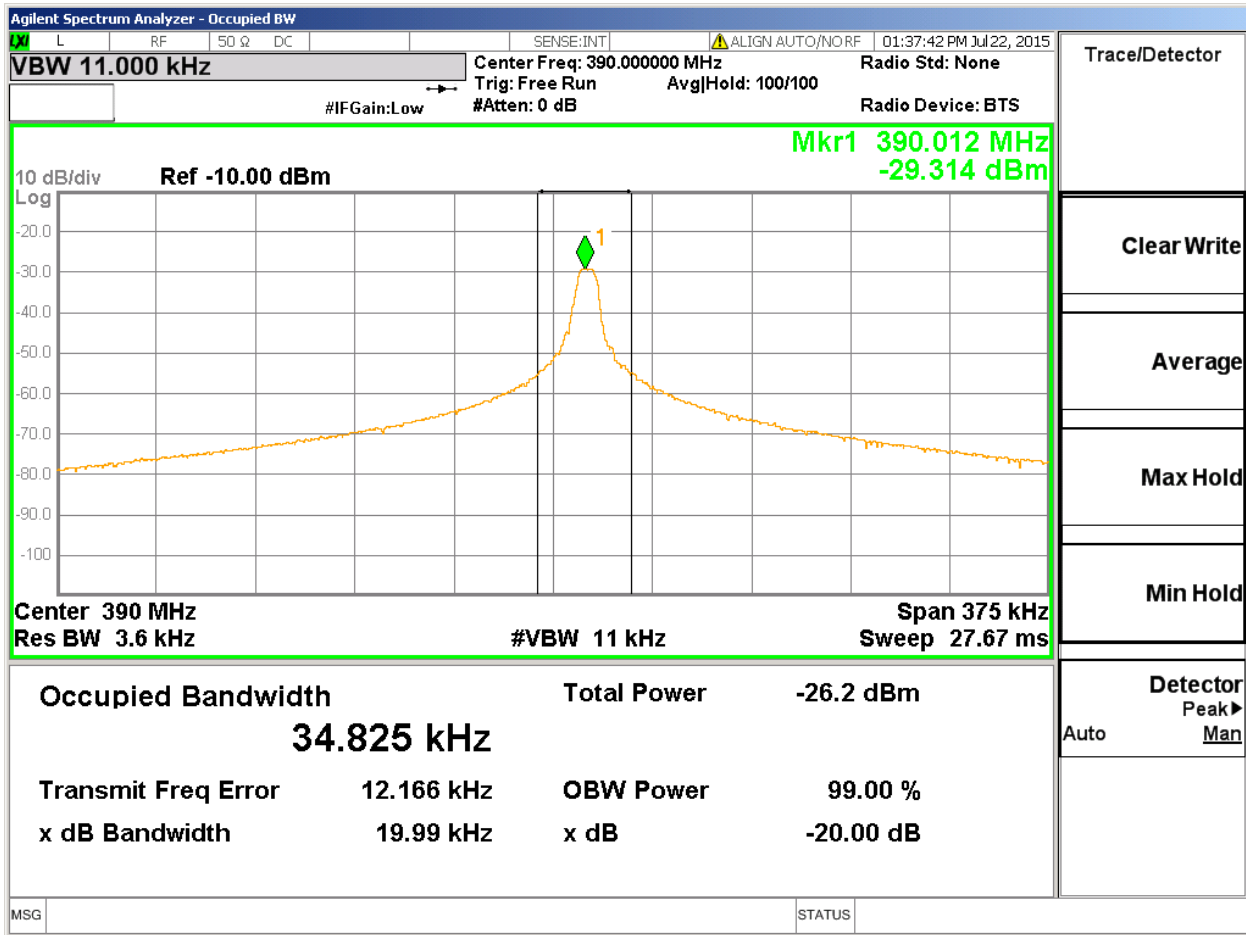
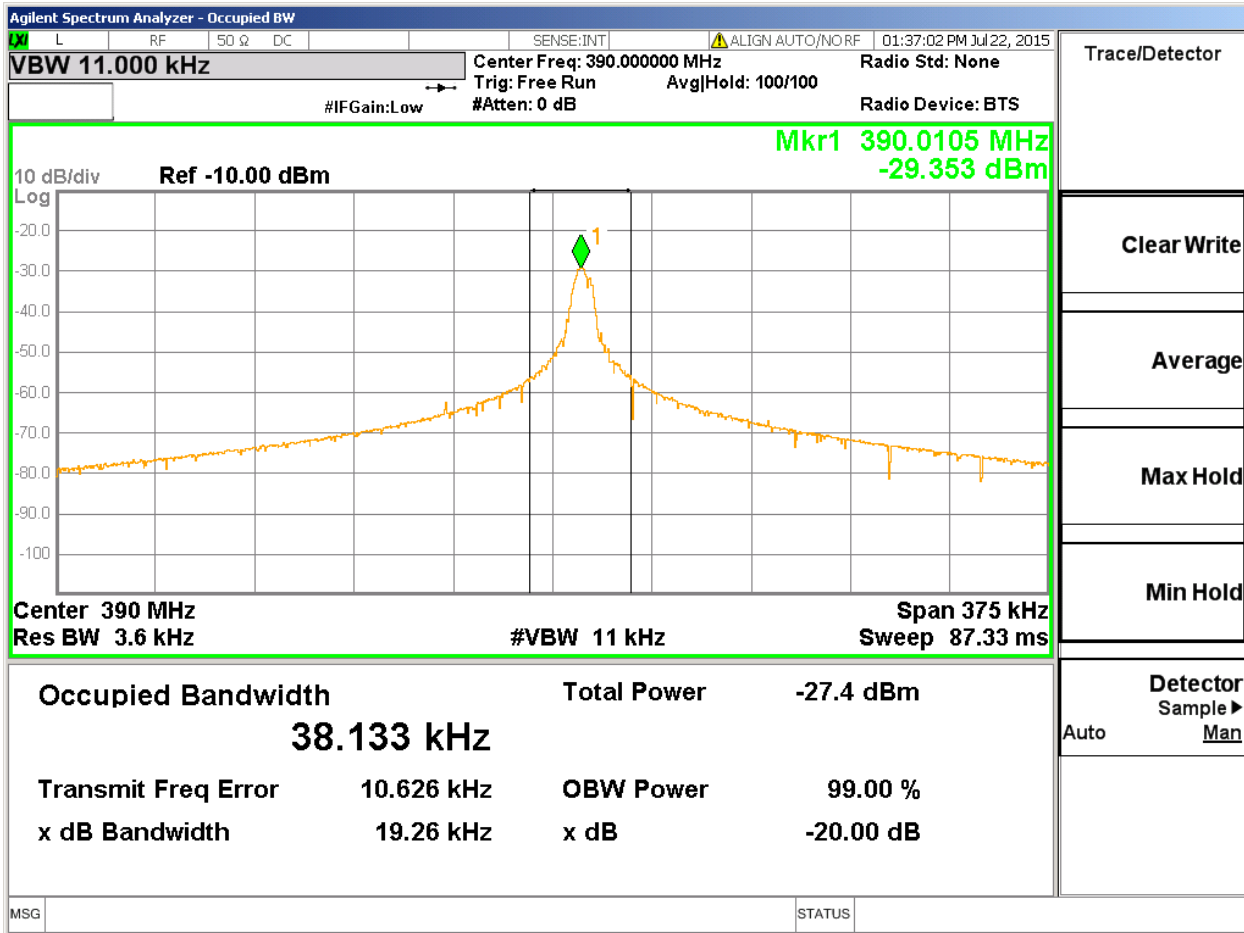


Figure 20 – 99% Bandwidth Graph



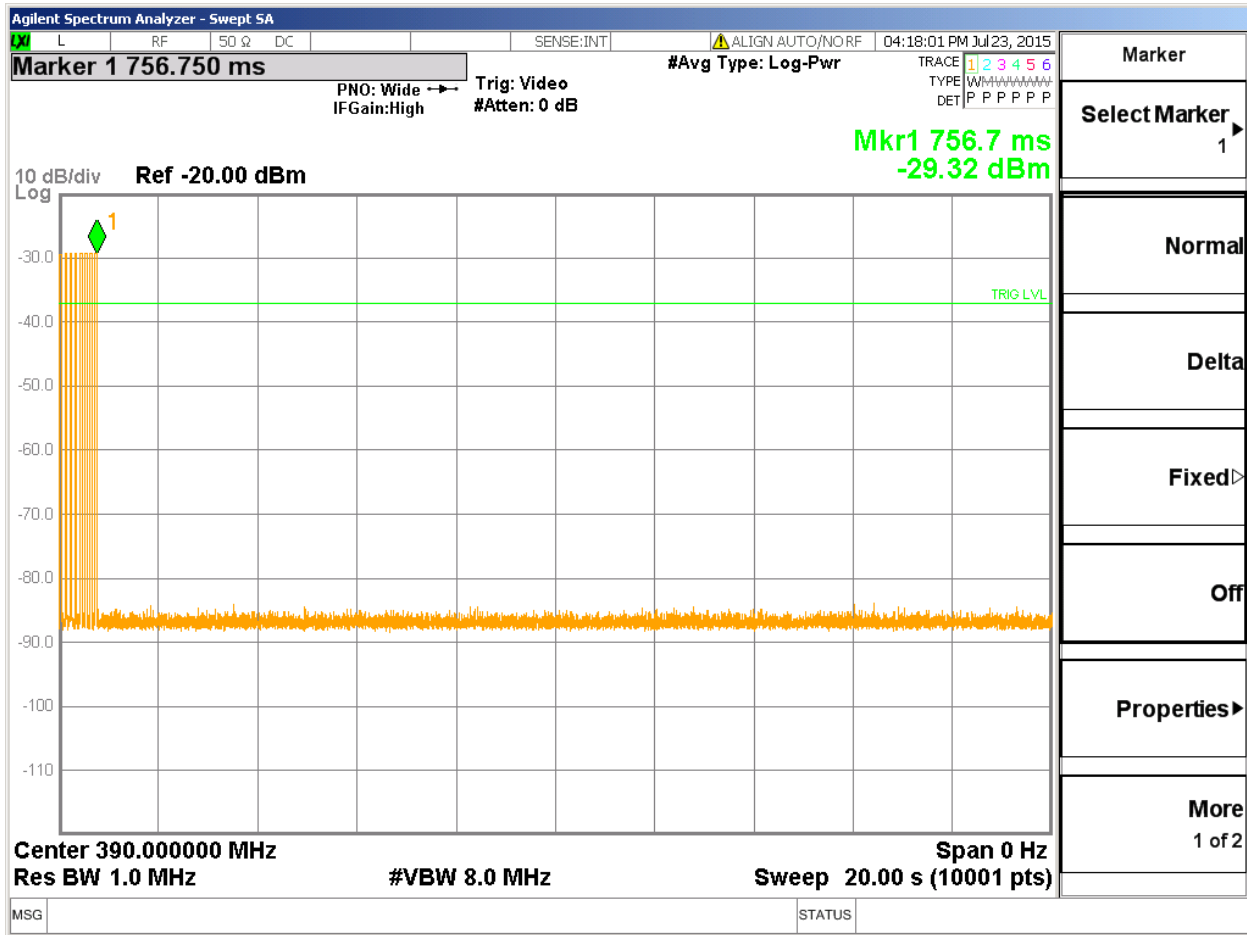
4.4.2 Test Conditions and Results – Cease Operation

Test Description	Measurements were made in the laboratory environment. A Dipole (or equivalent) antenna tuned to the transmit frequency was attached to the input of a spectrum analyzer. The device was operated and the transmission time measured with the spectrum analyzer set to zero span at the fundamental frequency.	
Basic Standard	47 CFR Part 15.231(a)	
Cease Operation Limits		
The transmissions shall stop within 5 seconds of either a button being released or if automatically controlled transmissions shall be stopped 5 seconds after transmissions begin.		

Table 28 Cease Operation Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	1	1
Supplementary information: None		

Figure 21 Cease Operation Graph



4.4.3 Test Conditions and Results – Pulse Train

Test Description	Measurements were made in the laboratory environment. A Dipole (or equivalent) antenna tuned to the transmit frequency was attached to the input of a spectrum analyzer. The pulse train was measured with the spectrum analyzer set to zero span at the fundamental frequency.	
Basic Standard	FCC Part 15 Subpart A, 15.35	
Pulse Train Limits		
There are no limits for this test. This data is used to calculate the averaging correction factor that is applied to the measured peak radiated emissions results.		

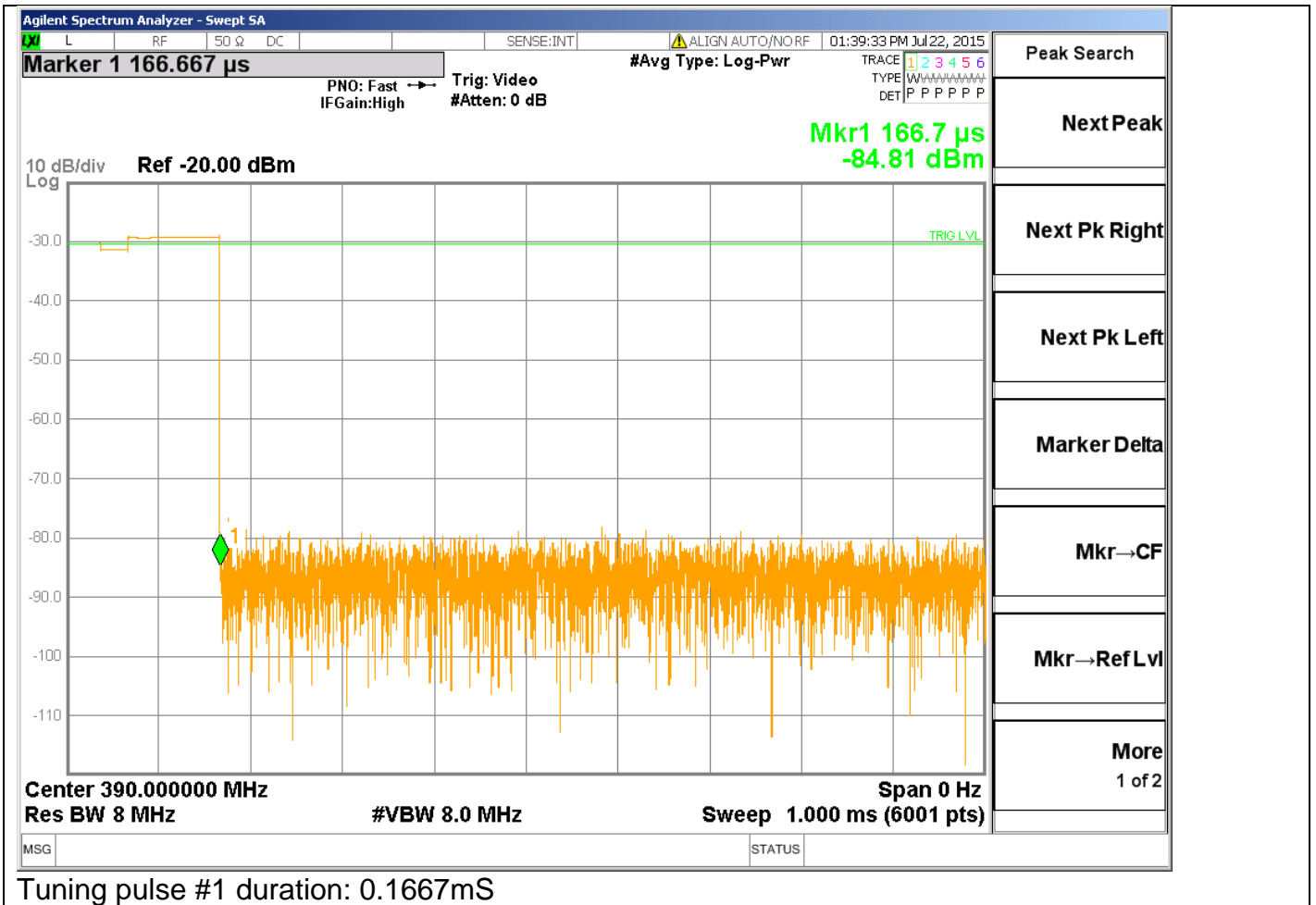
Table 29 Pulse Train Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	1	1
Supplementary information: None		

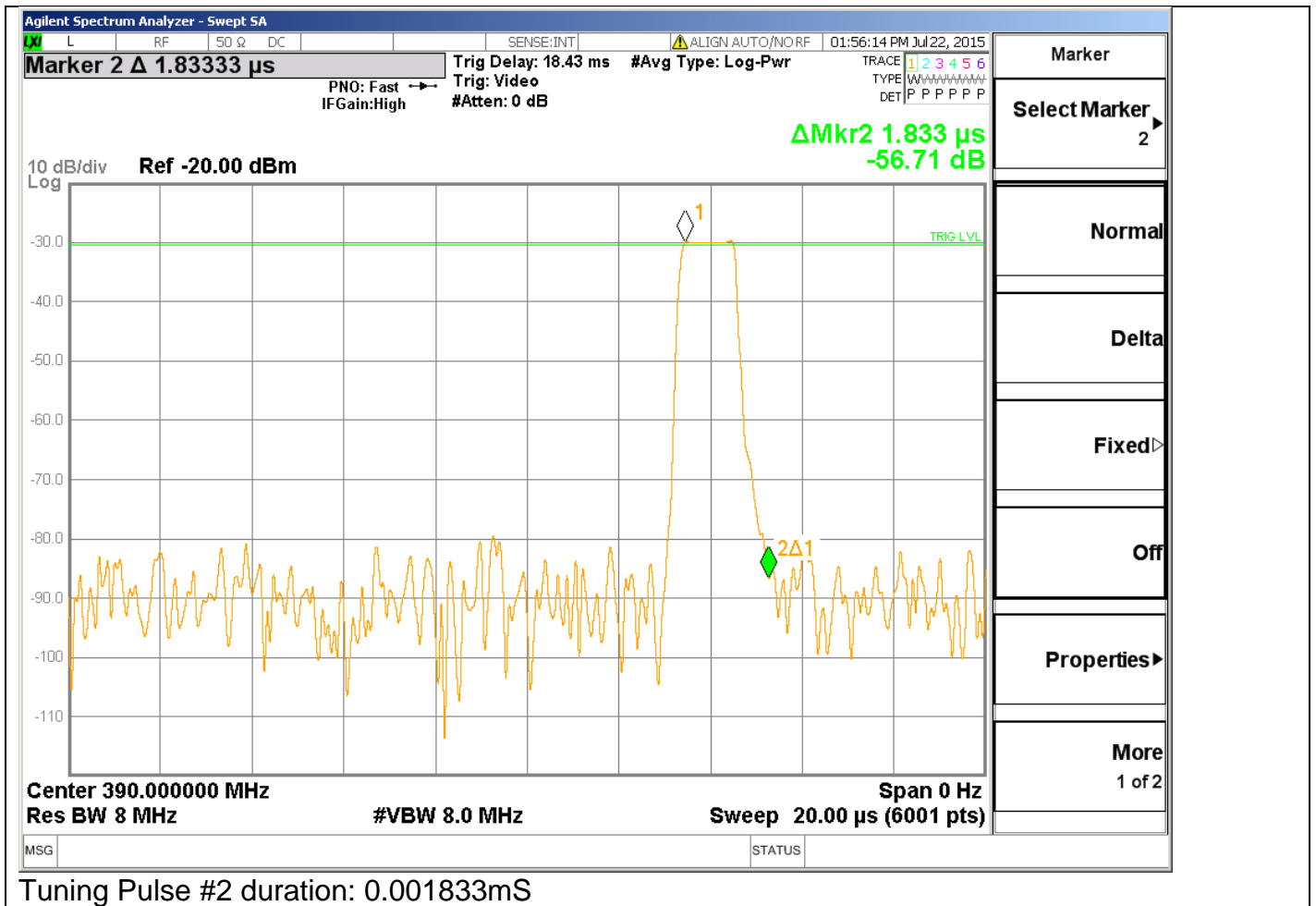
Table 30 Pulse Train Calculation

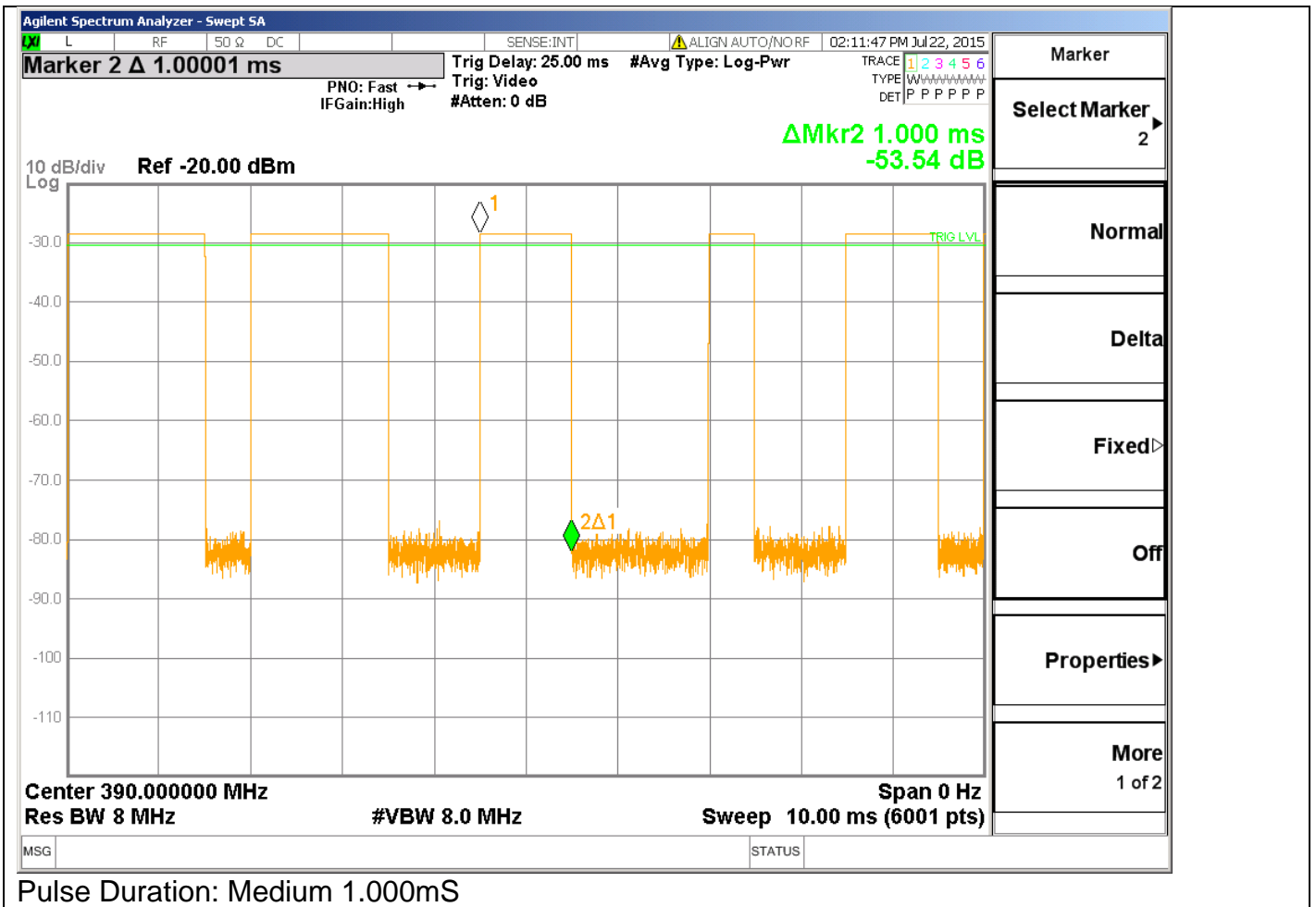
TX Frequency	Total TX time	Total Transmission period or 100ms whichever is lesser	DC Correction Factor (dB) $20\log\left(\frac{PulseWidth}{Period}\right)$
390MHz	$(10 \times 0.500) + (6 \times 1.00) + (5 \times 1.497) = 18.485mS$	97.40mS	-14.43dB
Worst Case Duty Cycle: Worst case duty cycle was calculated over normal period not including the tuning pulses. The manufacturer declared duty cycle as -10.17dB, declared duty cycle is used for all radiated emissions data.			

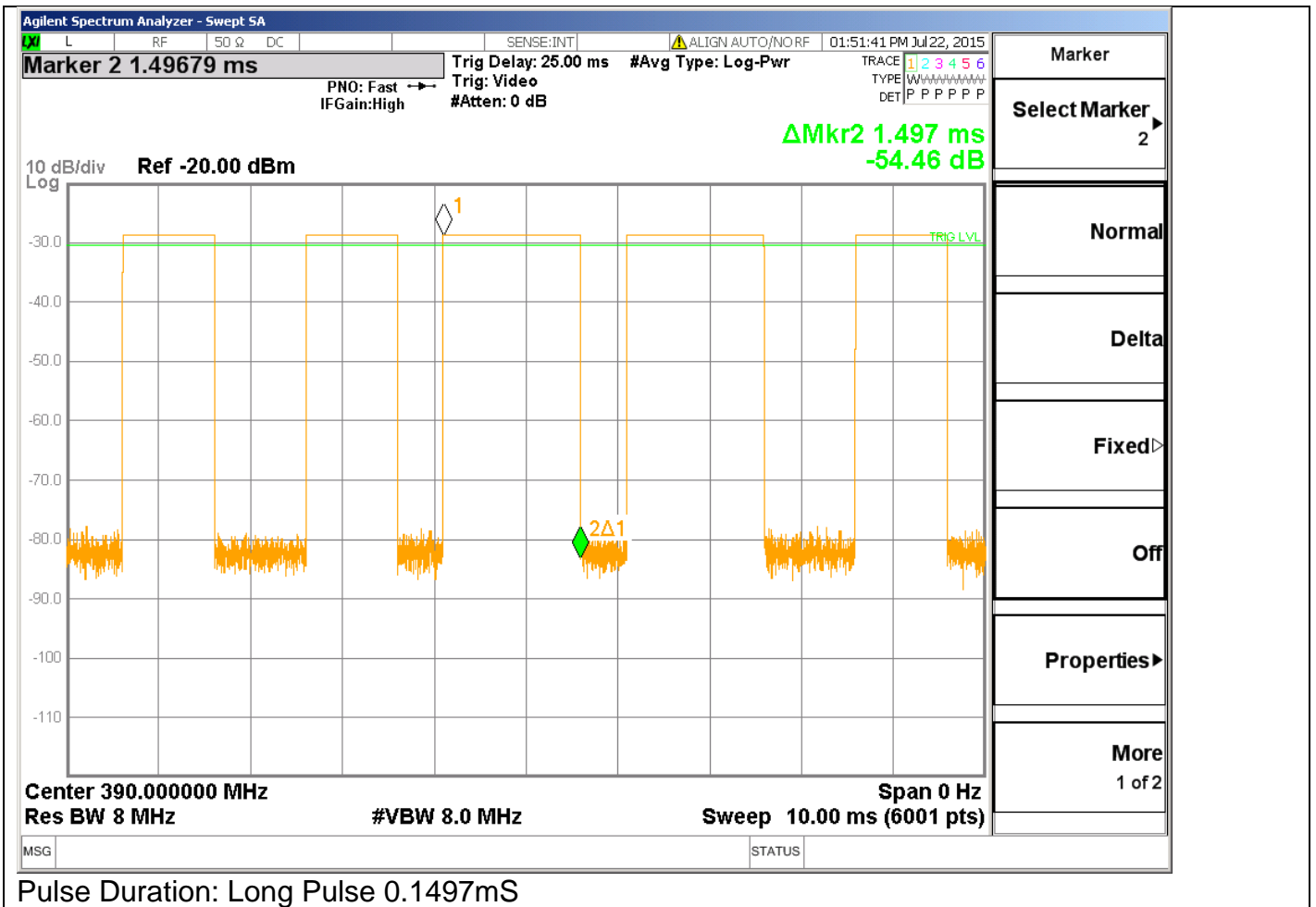
Figure 22 Pulse Train Graphs for 310MHz

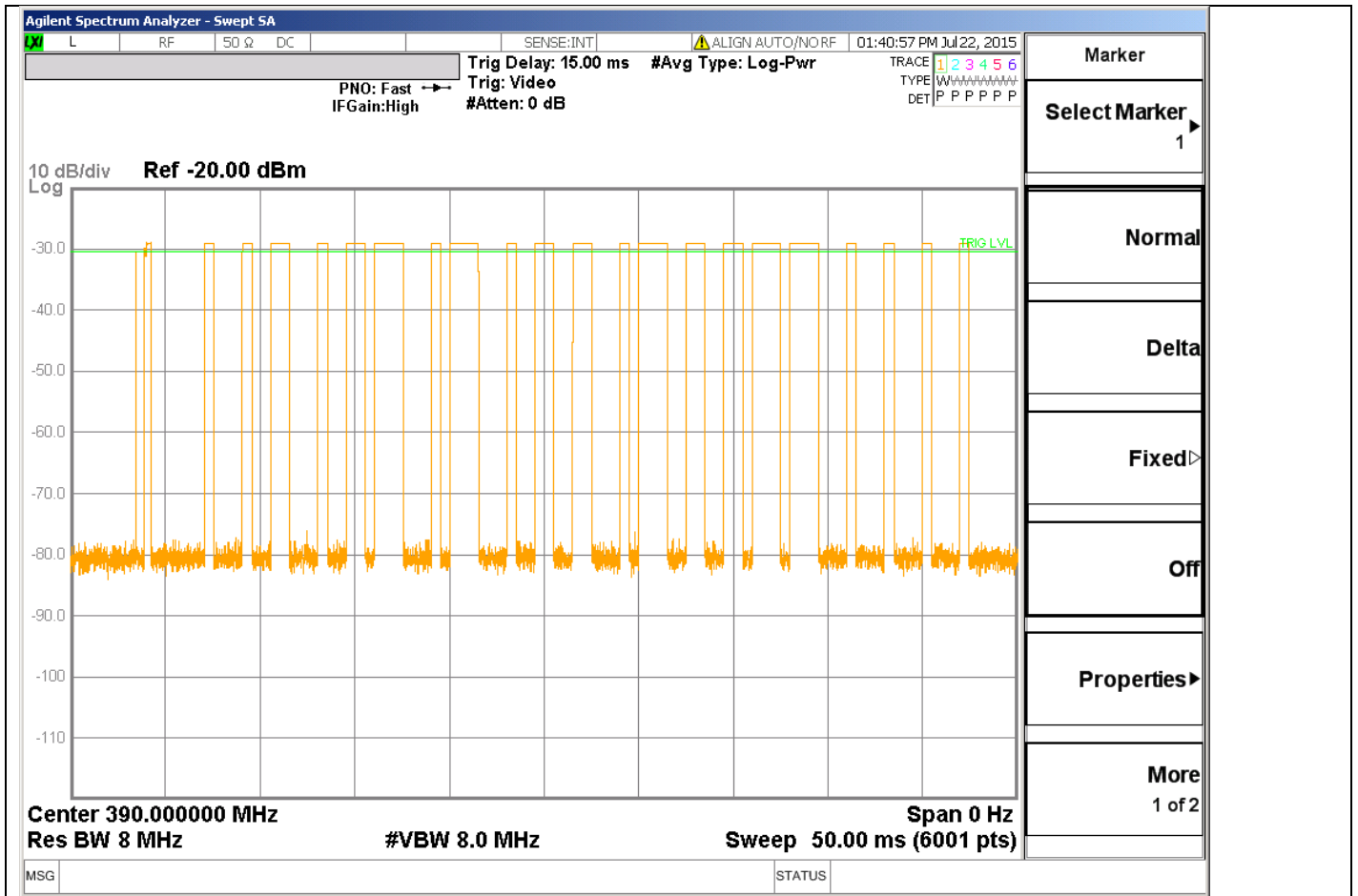


Tuning pulse #1 duration: 0.1667mS







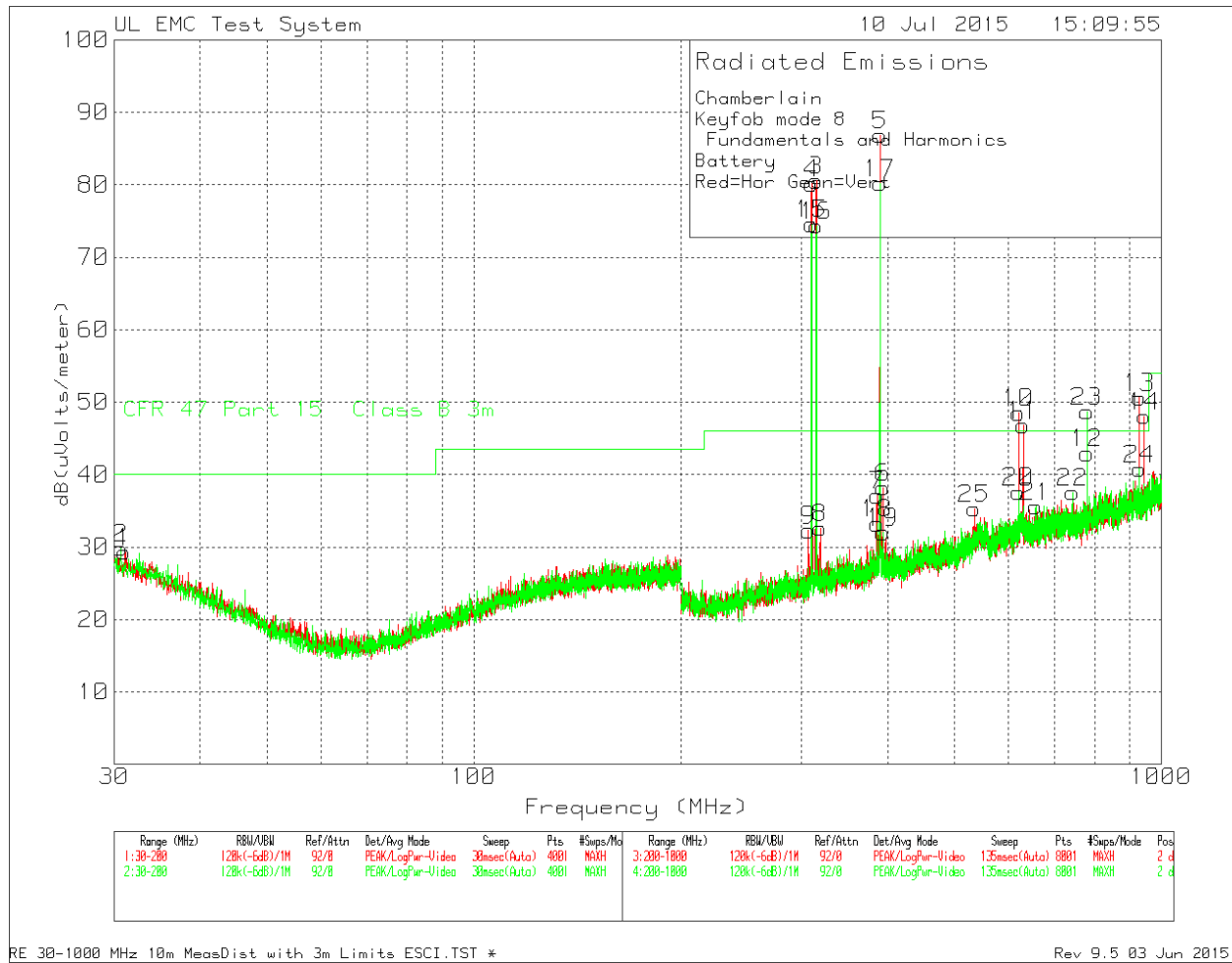


Number of Pulses: 10 Short, 6 Medium, 5 Long

4.4.4 Test Conditions and Results – RADIATED EMISSIONS Fundamental and Spurious

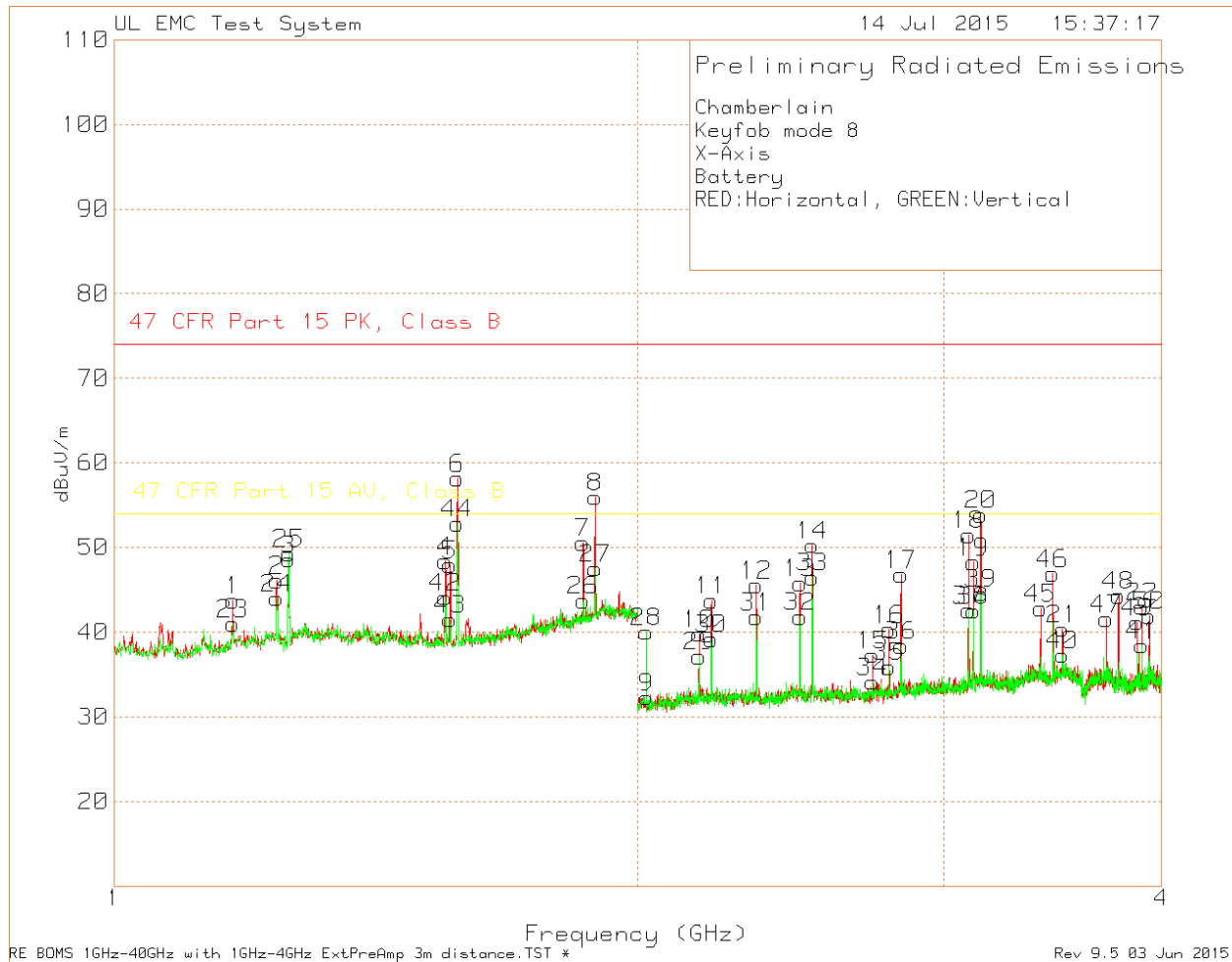
Test Description	Measurements were made in a 10-meter semi-anechoic chamber that complies to CISPR 16/ANSI C63.10:2009. Preliminary (peak) measurements were performed at an antenna to EUT separation distance of 3-meter as noted. The EUT was rotated 360° about its azimuth with the receive antenna located at various heights in both horizontal and vertical polarities. Final measurements (quasi-peak or average as noted) were then performed by rotating the EUT 360° and adjusting the receive antenna height from 1 to 4-meters. All frequencies were investigated in both horizontal and vertical antenna polarity, where applicable.	
Basic Standard	47 CFR Part 15 subpart C, and RSS-210	
UL LPG	80-EM-S0029	
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	30MHz – 1GHz	3 meter distance
	1GHz – 4GHz	3 meter distance
Out of band spurious emissions limit		
Frequency (MHz)	Limit (dB μ V/m)	
	Quasi-Peak	Peak
30 - 88	40.00	NA
88 - 216	43.52	NA
216 - 960	46.02	NA
960 - 1000	54	NA
Above 1000 (FCC)	NA	54 (at 3-meter)
Fundamental Frequency Limits and Non-restricted band Harmonic Limits		
Frequency (MHz)	Limit (dB μ V/m) @ 3m distance All harmonics except those in restricted bands must be attenuated by 20dB or more	
	Average - Fundamental	Peak - Fundamental
390	79.24	99.24
Supplementary information: See section 4.4.3 for duty cycle information.		

Figure 23 Radiated Emissions Graph (Below 1GHz)



Above scan is for mode #8. Mode #8 uses the same frequencies as mode #4 with few additional ones. The drive level for mode #8 is higher than drive for mode #4 therefore conducting a scan with mode #8 was considered as worst case.

Figure 24 Radiated Emissions Graph (Above 1GHz)



Above scan is for mode #8. Mode #8 uses the same frequencies as mode #4 with few additional ones. The drive level for mode #8 is higher than drive for mode #4 therefore conducting a scan with mode #8 was considered as worst case.

Table 31 - Radiated Emissions Data Points Below 1GHz

Test Frequency (MHz)	Meter Reading (dBuV)	Detector	Antenna Factor dB/m	Path Factor dB	Peak Level dBuV/m	DC Factor dB	Average Level with DC dBuV/m	Peak Limit dBuV/m	Peak Margin dB	Average Limit dBuV/m	Average Margin dB	Azimuth [Degs]	Height [cm]	Polarity	Notes
390.0149	62.51	Pk	16.2	8.4	87.11	-10.17	76.94	99.24	-12.13	79.24	-2.3	312	101	H	1
390.0149	41.27	Pk	16.2	8.4	65.87	-10.17	55.7	99.24	-33.37	79.24	-23.54	268	108	V	1
390.02	56.39	Pk	16.2	8.4	80.99	-10.17	70.82	99.24	-18.25	79.24	-8.42	38	183	H	2
390.016	61.77	Pk	16.2	8.4	86.37	-10.17	76.2	99.24	-12.87	79.24	-3.04	147	155	V	2
390.018	56.16	Pk	16.2	8.4	80.76	-10.17	70.59	99.24	-18.48	79.24	-8.65	34	181	H	3
390.017	62.02	Pk	16.2	8.4	86.62	-10.17	76.45	99.24	-12.62	79.24	-2.79	41	180	H	3
780.024	17.02	Pk	21.8	9.9	48.72	-10.17	38.55	66.02	-17.3	46.02	-7.47	3	248	V	1
780.018	9.71	Pk	21.8	9.9	41.41	-10.17	31.24	66.02	-24.61	46.02	-14.78	308	114	H	1
780.026	8.65	Pk	21.8	9.9	40.35	-10.17	30.18	66.02	-25.67	46.02	-15.84	309	101	H	2
780.034	14.25	Pk	21.8	9.9	45.95	-10.17	35.78	66.02	-20.07	46.02	-10.24	226	157	V	2
780.045	19.32	Pk	21.8	9.9	51.02	-10.17	40.85	66.02	-15	46.02	-5.17	262	208	V	3
780.02	8.87	Pk	21.8	9.9	40.57	-10.17	30.4	66.02	-25.45	46.02	-15.62	198	108	H	3
Notes:															
1 - X- Axis (Laying Flat) 315MHz															
2 - Z- Axis (Straight Up) 315MHz															
3 - Y- Axis (Sideways) 315MHz															
Pk - Peak detector															

Below 1GHz all measurement data was collected with transmitter set to mode #2 (higher output power) and duty cycle for mode #4. It was considered as worst case.

Table 32 - Radiated Emissions Data Points Above 1GHz

Marker No.	Test Frequency (GHz)	Meter Reading (dBuV)	Detector	Antenna Factor dB/m	Path Factor dB	Peak Level dBuV/m	DC Factor dB	Average Level with DB dBuV/m	Peak Limit dBuV/m	Peak Margin dB	Average Limit dBuV/m	Average Margin dB	Azimuth [Degs]	Height [cm]	Polarity
1	1.17	71.9	Pk	28.2	-56.34	43.76	-10.17	33.59	74	-30.24	54	-20.41	0-360	100	H
23	1.17	69.11	Pk	28.2	-56.34	40.97	-10.17	30.8	74	-33.03	54	-23.2	0-360	150	V
5	1.56	74.56	Pk	28.2	-54.85	47.91	-10.17	37.74	74	-26.09	54	-16.26	0-360	150	H
43	1.56	68.17	Pk	28.2	-54.85	41.52	-10.17	31.35	74	-32.48	54	-22.65	0-360	150	V
12	2.34	75.69	Pk	21.7	-51.87	45.52	-10.17	35.35	74	-28.48	54	-18.65	0-360	99	H
31	2.34	71.95	Pk	21.7	-51.87	41.78	-10.17	31.61	74	-32.22	54	-22.39	0-360	100	V
15	2.73	66.52	Pk	22.1	-51.31	37.31	-10.17	27.14	74	-36.69	54	-26.86	0-360	99	H
34	2.73	63.34	Pk	22.1	-51.31	34.13	-10.17	23.96	74	-39.87	54	-30.04	0-360	150	V
19	3.12	76.16	Pk	22.7	-50.61	48.25	-10.17	38.08	74	-25.75	54	-15.92	0-360	99	H
38	3.12	70.44	Pk	22.7	-50.61	42.53	-10.17	32.36	74	-31.47	54	-21.64	0-360	100	V
21	3.51	66.84	Pk	23.5	-49.96	40.38	-10.17	30.21	74	-33.62	54	-23.79	0-360	99	H
40	3.51	63.76	Pk	23.5	-49.96	37.3	-10.17	27.13	74	-36.7	54	-26.87	0-360	100	V
22	3.901	70.59	Pk	23.8	-51.38	43.01	-10.17	32.84	74	-30.99	54	-21.16	0-360	150	H
41	3.901	66.02	Pk	23.8	-51.38	38.44	-10.17	28.27	74	-35.56	54	-25.73	0-360	100	V
9	2.024	64.39	Pk	21.2	-53.29	32.3	0	-	74	-41.7	54	-21.7	0-360	150	H
45	3.41	69.97	Pk	23.5	-50.66	42.81	0	-	74	-31.19	54	-11.19	0-360	99	H
46	3.465	74.39	Pk	23.5	-50.99	46.9	0	-	74	-27.1	54	-7.1	0-360	99	H
47	3.721	67.86	Pk	23.6	-49.9	41.56	0	-	74	-32.44	54	-12.44	0-360	150	H
48	3.781	71.77	Pk	24	-51.46	44.31	0	-	74	-29.69	54	-9.69	0-360	150	H
49	3.876	68.41	Pk	23.9	-51.15	41.16	0	-	74	-32.84	54	-12.84	0-360	150	H
50	3.938	68.86	Pk	24	-50.95	41.91	0	-	74	-32.09	54	-12.09	0-360	99	H
28	2.023	72.09	Pk	21.2	-53.27	40.02	0	-	74	-33.98	54	-13.98	0-360	150	V
Pk - Peak detector															

For above 1GHz all measurement data was collected with transmitter set to mode #8 (higher output power) and duty cycle from mode #4. Because all emission levels are under the limit it was considered worst case and it was considered not necessary to re-do measurement with transmitter set to mode #2.

4.5 Mode#5 Test Data

4.5.1 Test Conditions and Results – Occupied Bandwidth

Test Description	Measurements were made in the laboratory environment. A Dipole (or equivalent) antenna tuned to the transmit frequency was attached to the input of a spectrum analyzer. The device was operated and the spectrum analyzer resolution bandwidth set per the appropriate standard.	
Basic Standard	47 CFR Part 15.231(c)	
Occupied Bandwidth Limits		
0.25% of Center Frequency (315MHz: 787.50kHz)		

Table 33 Occupied Bandwidth Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	1	1
Supplementary information: None		

Table 34 Occupied Bandwidth Spectrum Analyzer Settings

Resolution Bandwidth	Occupied Bandwidth Requirements	
	dBc	% PWR
10kHz	-20	99
Supplementary information: None		

Table 35 Occupied Bandwidth Test Result Summary

Center Frequency	20dB BW Measured (kHz)	99% BW Measured (kHz)
315MHz	14.72	26.603

Figure 25 –20dB Bandwidth Graph

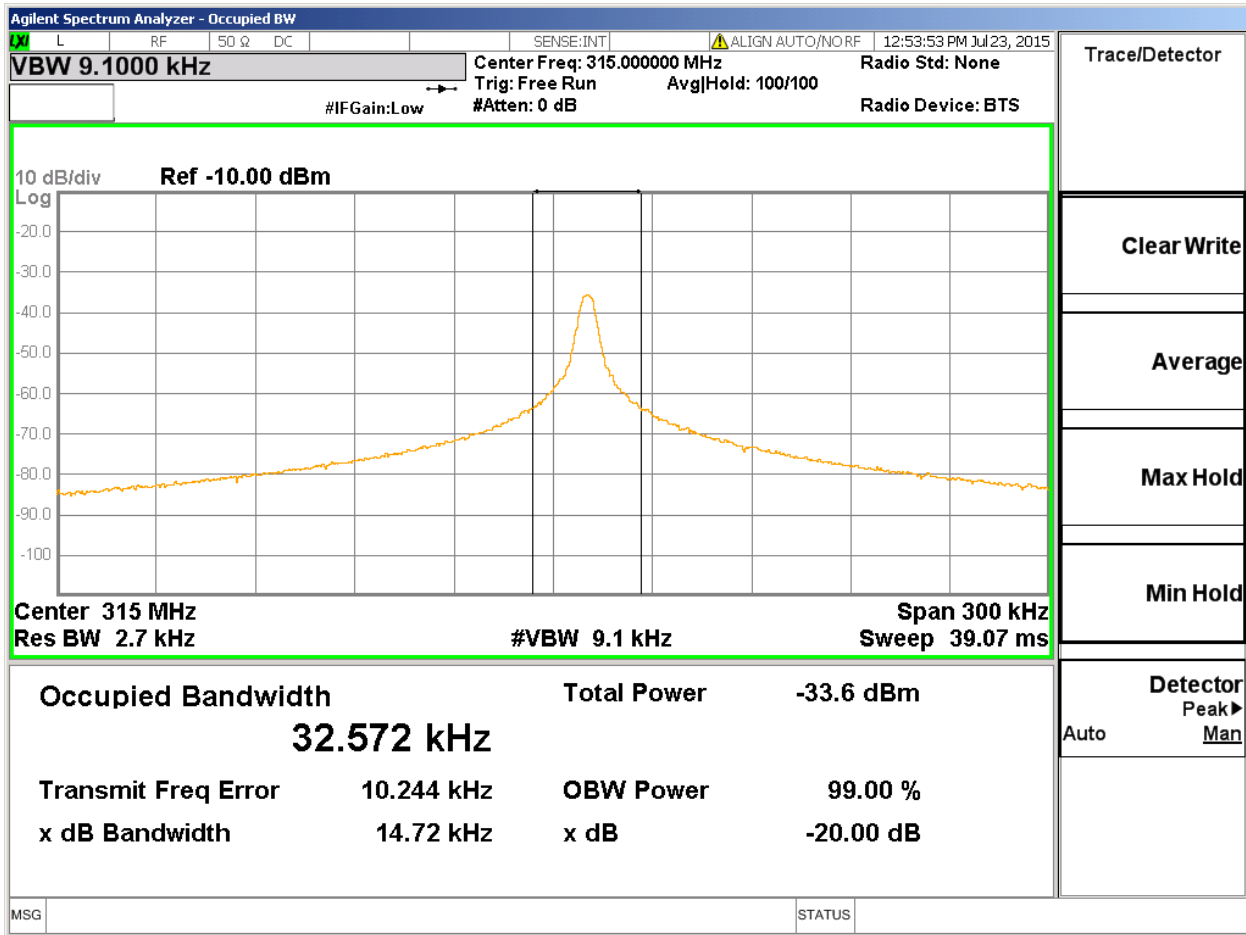
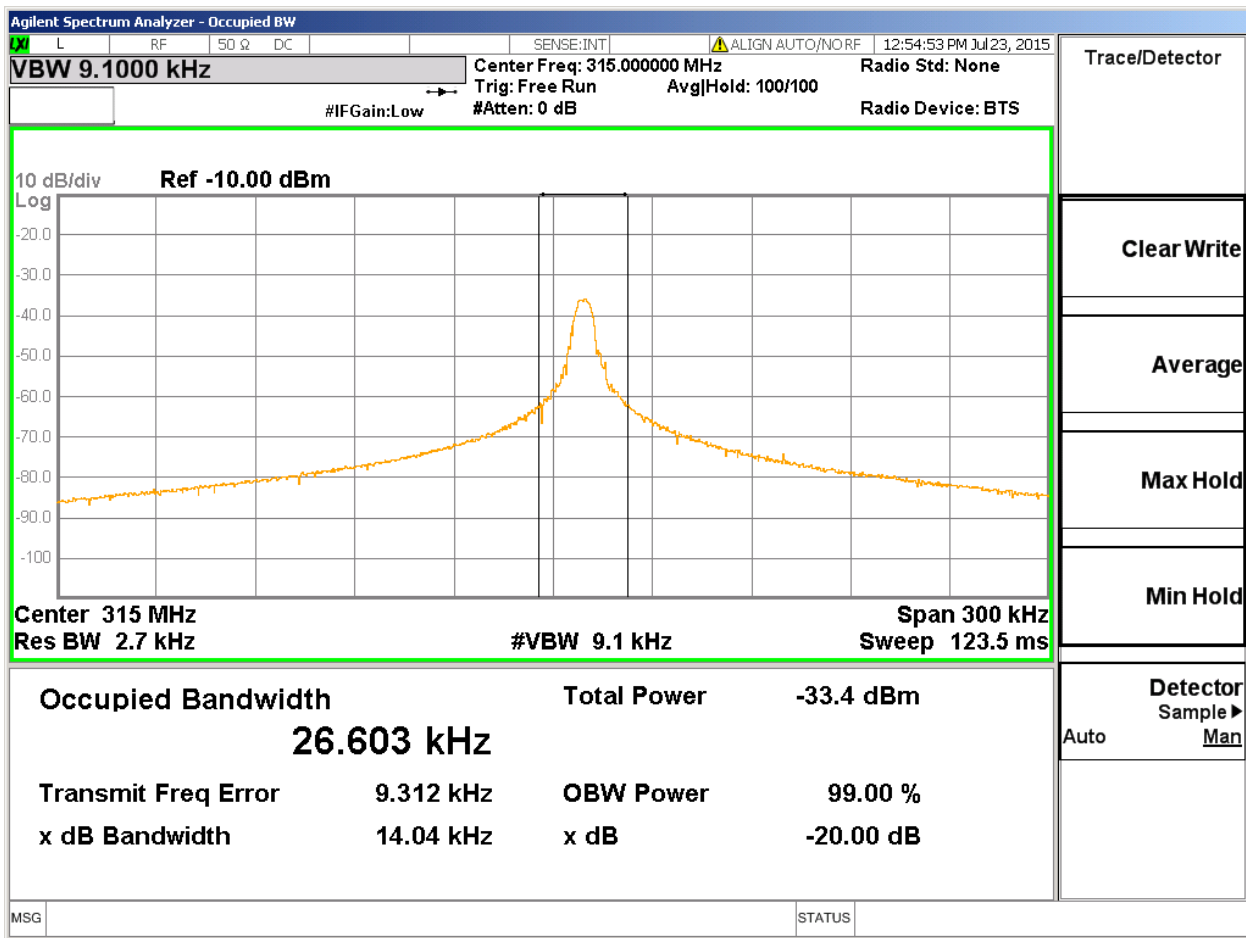


Figure 26 – 99% Bandwidth Graph



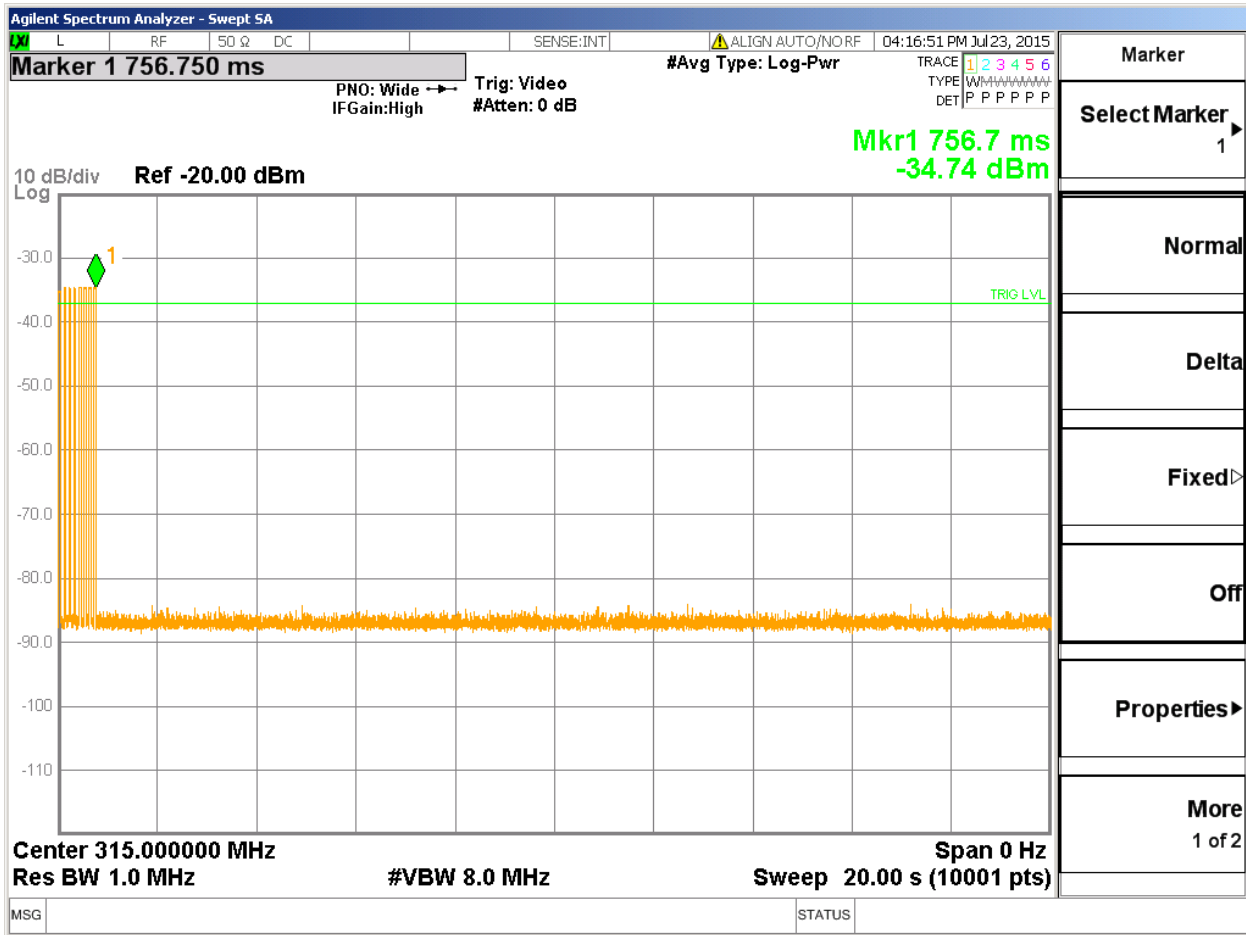
4.5.2 Test Conditions and Results – Cease Operation

Test Description	Measurements were made in the laboratory environment. A Dipole (or equivalent) antenna tuned to the transmit frequency was attached to the input of a spectrum analyzer. The device was operated and the transmission time measured with the spectrum analyzer set to zero span at the fundamental frequency.	
Basic Standard	47 CFR Part 15.231(a)	
Cease Operation Limits		
The transmissions shall stop within 5 seconds of either a button being released or if automatically controlled transmissions shall be stopped 5 seconds after transmissions begin.		

Table 36 Cease Operation Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	1	1
Supplementary information: None		

Figure 27 Cease Operation Graph



4.5.3 Test Conditions and Results – Pulse Train

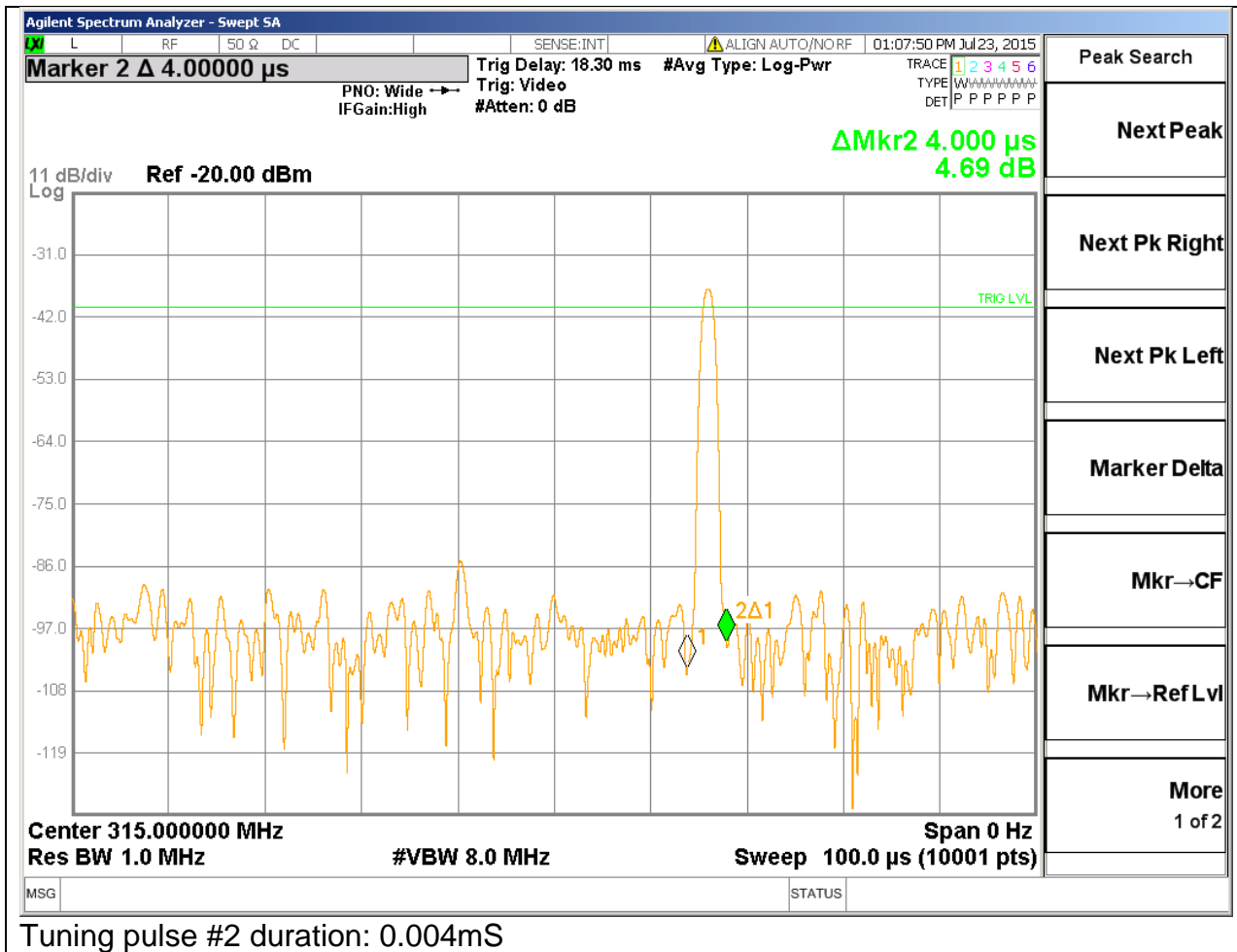
Test Description	Measurements were made in the laboratory environment. A Dipole (or equivalent) antenna tuned to the transmit frequency was attached to the input of a spectrum analyzer. The pulse train was measured with the spectrum analyzer set to zero span at the fundamental frequency.	
Basic Standard	FCC Part 15 Subpart A, 15.35	
Pulse Train Limits		
There are no limits for this test. This data is used to calculate the averaging correction factor that is applied to the measured peak radiated emissions results.		

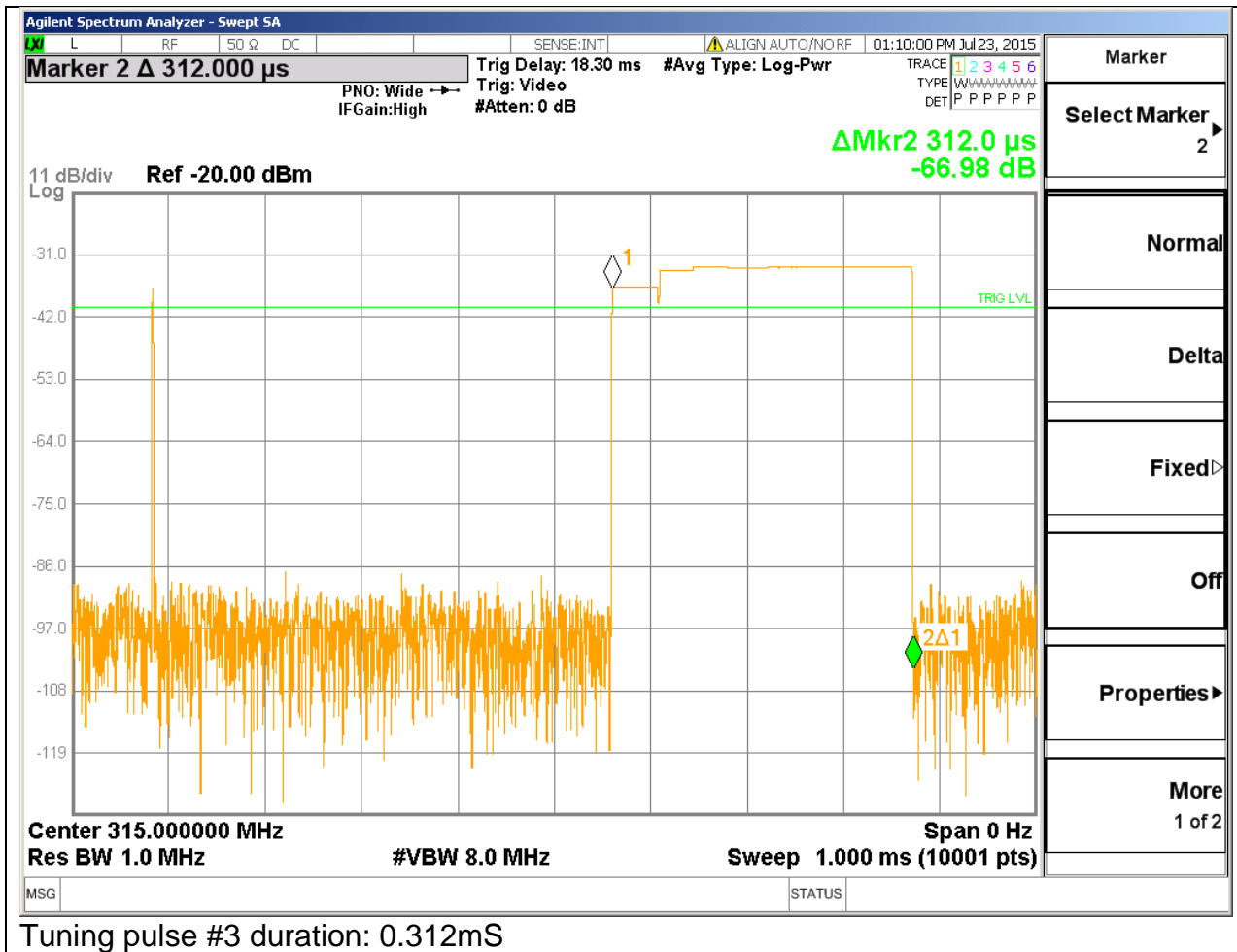
Table 37 Pulse Train Configuration Settings

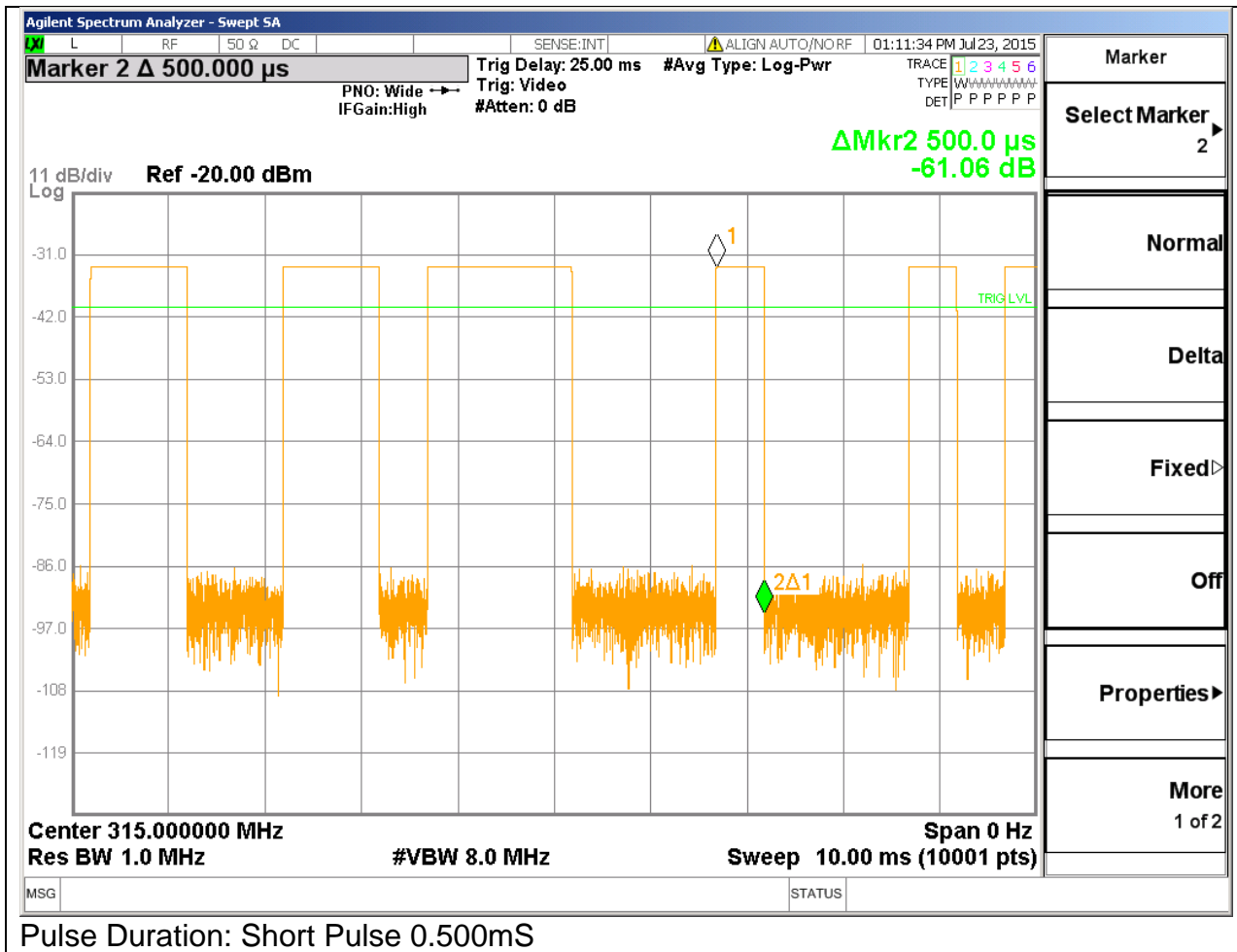
Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	1	1
Supplementary information: None		

Table 38 Pulse Train Calculation

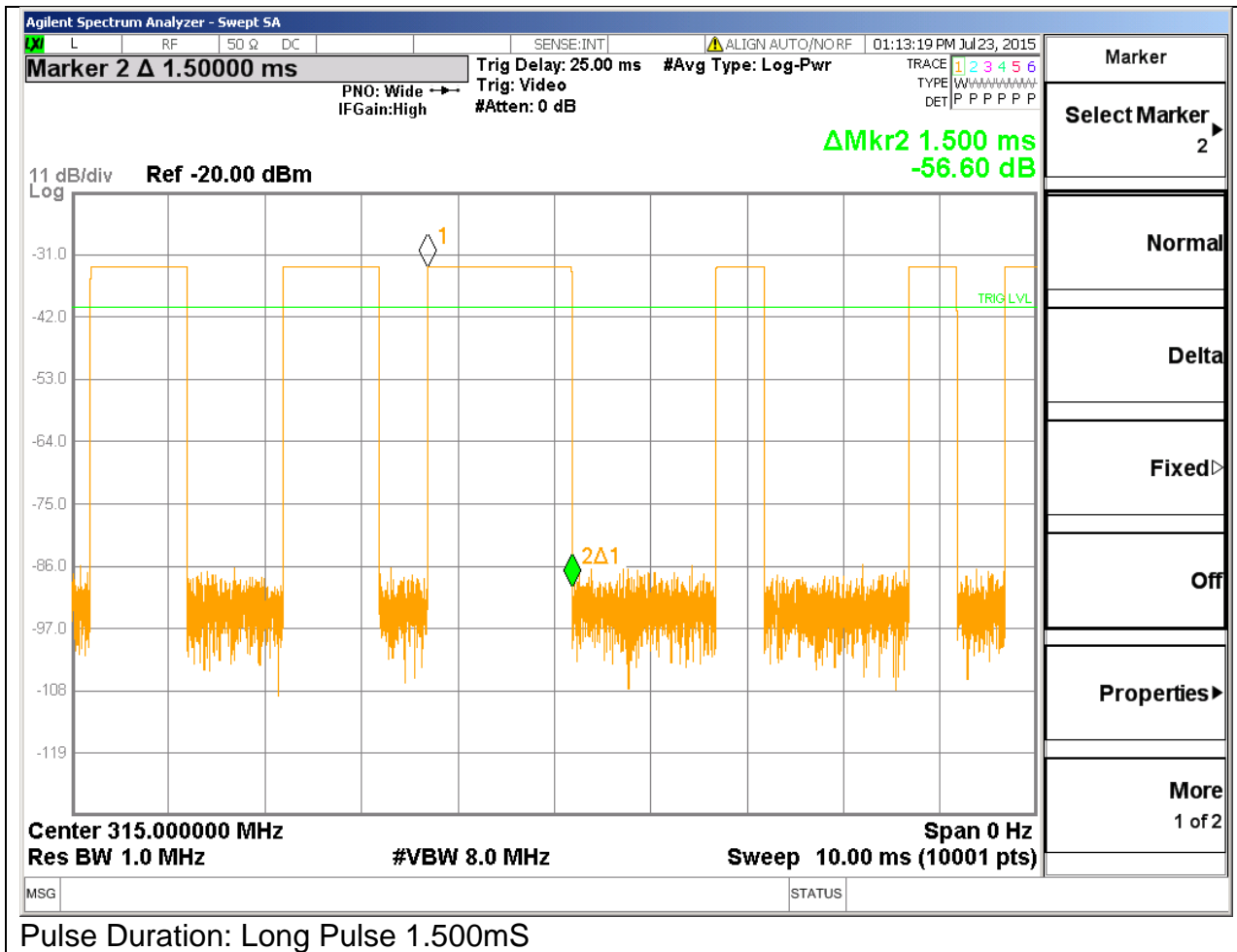
TX Frequency	Total TX time	Total Transmission period or 100ms whichever is lesser	DC Correction Factor (dB)
			$20 \log \left(\frac{PulseWidth}{Period} \right)$
315MHz	$(6 \times 3.0) + (7 \times 1.0) + (8 \times 1.5) + 0.1251 + 0.004 + 0.312 = 22.4411mS$	100mS	-12.97dB
Worst Case Duty Cycle: Worst case duty cycle was calculated over normal 1000mS including the tuning pulses. The manufacturer declared duty cycle as -10.17dB, declared duty cycle is used for all radiated emissions data.			





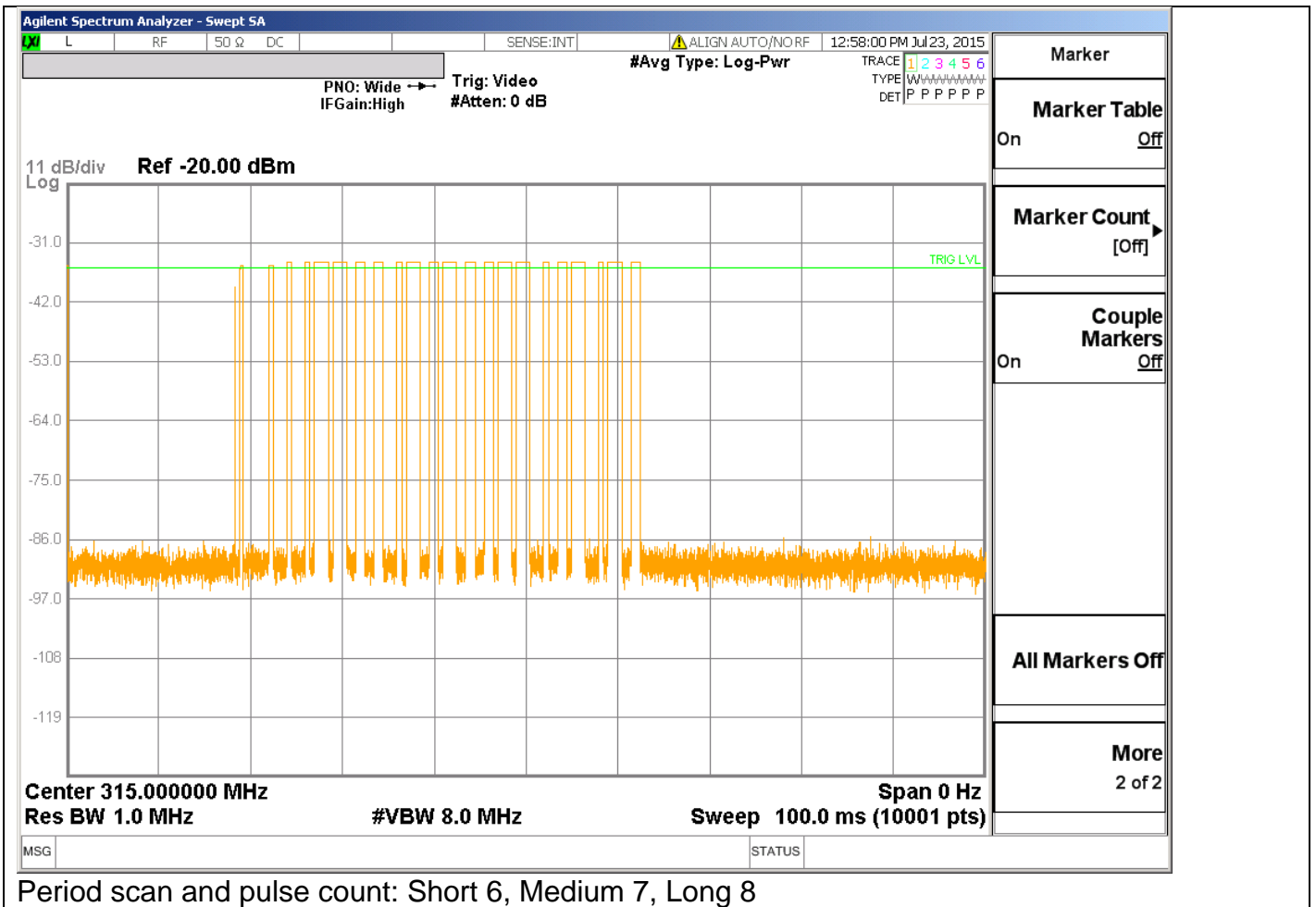








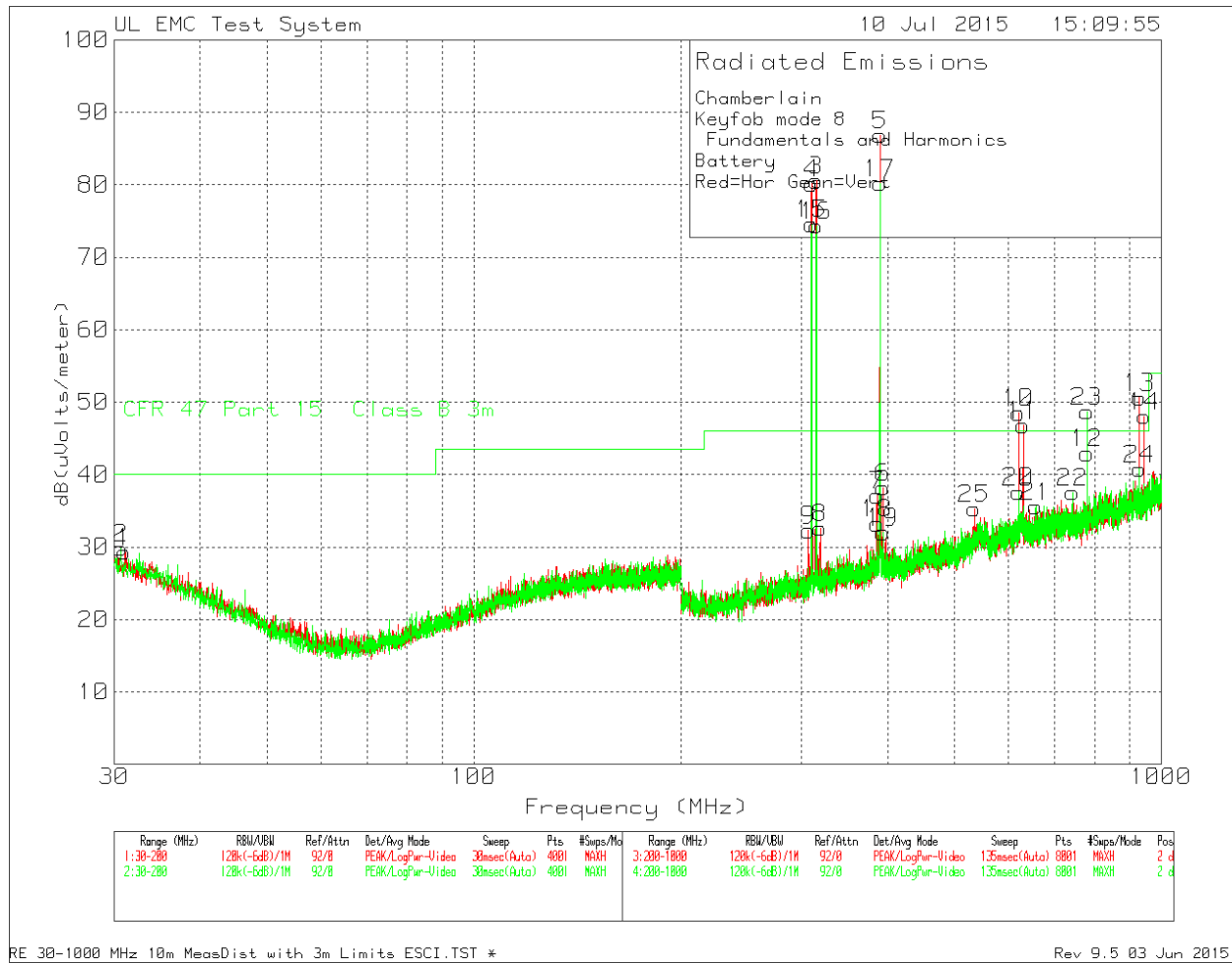
Period



4.5.4 Test Conditions and Results – RADIATED EMISSIONS Fundamental and Spurious

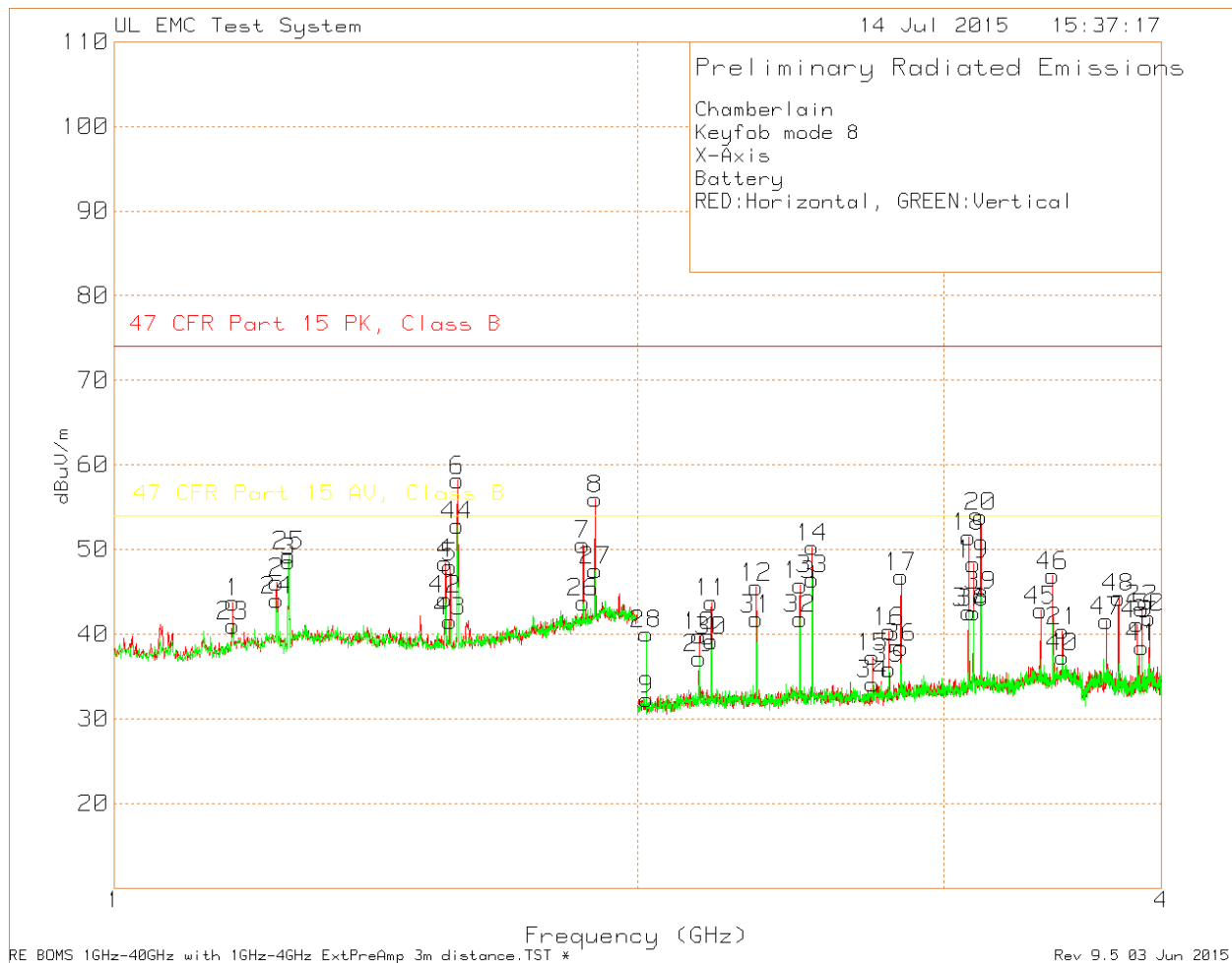
Test Description	Measurements were made in a 10-meter semi-anechoic chamber that complies to CISPR 16/ANSI C63.10:2009. Preliminary (peak) measurements were performed at an antenna to EUT separation distance of 3-meter as noted. The EUT was rotated 360° about its azimuth with the receive antenna located at various heights in both horizontal and vertical polarities. Final measurements (quasi-peak or average as noted) were then performed by rotating the EUT 360° and adjusting the receive antenna height from 1 to 4-meters. All frequencies were investigated in both horizontal and vertical antenna polarity, where applicable.	
Basic Standard	47 CFR Part 15 subpart C, and RSS-210	
UL LPG	80-EM-S0029	
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	30MHz – 1GHz	3 meter distance
	1GHz – 4GHz	3 meter distance
Out of band spurious emissions limit		
Frequency (MHz)	Limit (dB μ V/m)	
	Quasi-Peak	Peak
30 - 88	40.00	NA
88 - 216	43.52	NA
216 - 960	46.02	NA
960 - 1000	54	NA
Above 1000 (FCC)	NA	54 (at 3-meter)
Fundamental Frequency Limits and Non-restricted band Harmonic Limits		
Frequency (MHz)	Limit (dB μ V/m) @ 3m distance All harmonics except those in restricted bands must be attenuated by 20dB or more	
	Average - Fundamental	Peak - Fundamental
315	75.62	95.62
Supplementary information: See section 4.5.3 for duty cycle information.		

Figure 29 Radiated Emissions Graph (Below 1GHz)



Above scan is for mode #8. Mode #8 uses the same frequencies as mode #5 with few additional ones. The drive level for mode #8 is higher than drive for mode #5 therefore conducting a scan with mode #8 was considered as worst case.

Figure 30 Radiated Emissions Graph Above 1GHz



Above scan is for mode #8. Mode #8 uses the same frequencies as mode #5 with few additional ones. The drive level for mode #8 is higher than drive for mode #5 therefore conducting a scan with mode #8 was considered as worst case.

Table 39 - Radiated Emissions Data Points – Below 1GHz

Test Frequency (MHz)	Meter Reading (dBuV)	Detector	Antenna Factor dB/m	Path Factor dB	Peak Level dBuV/m	DC Factor dB	Average Level with DC dBuV/m	Peak Limit dBuV/m	Peak Margin dB	Average Limit dBuV/m	Average Margin dB	Azimuth [Degs]	Height [cm]	Polarity	Notes
315.013	61	Pk	14.3	8	83.3	-10.17	73.13	95.62	-12.32	75.62	-2.49	27	100	H	1
315.0153	40.1	Pk	14.3	8	62.4	-10.17	52.23	95.62	-33.22	75.62	-23.39	112	102	V	1
315.016	55.31	Pk	14.3	8	77.61	-10.17	67.44	95.62	-18.01	75.62	-8.18	224	238	H	2
315.013	58.23	Pk	14.3	8	80.53	-10.17	70.36	95.62	-15.09	75.62	-5.26	301	192	V	2
315.015	54.88	Pk	14.3	8	77.18	-10.17	67.01	95.62	-18.44	75.62	-8.61	227	231	H	3
315.016	58.65	Pk	14.3	8	80.95	-10.17	70.78	95.62	-14.67	75.62	-4.84	313	189	V	3
630.034	11.87	Pk	20.7	9.2	41.77	-10.17	31.6	66.02	-24.25	46.02	-14.42	318	139	H	1
630.0175	6.25	Pk	20.7	9.2	36.15	-10.17	25.98	66.02	-29.87	46.02	-20.04	217	103	V	1
630.041	8.25	Pk	20.7	9.2	38.15	-10.17	27.98	66.02	-27.87	46.02	-18.04	351	125	H	2
630.0275	10.94	Pk	20.7	9.2	40.84	-10.17	30.67	66.02	-25.18	46.02	-15.35	308	101	V	2
630.039	9.73	Pk	20.7	9.2	39.63	-10.17	29.46	66.02	-26.39	46.02	-16.56	54	154	H	3
630.0185	9.31	Pk	20.7	9.2	39.21	-10.17	29.04	66.02	-26.81	46.02	-16.98	327	191	V	3
945.0499	12.4	Pk	23.9	10.5	46.8	-10.17	36.63	66.02	-19.22	46.02	-9.39	69	165	H	1
945.0824	8.22	Pk	23.9	10.5	42.62	-10.17	32.45	66.02	-23.4	46.02	-13.57	287	114	V	1
945.0399	12.03	Pk	23.9	10.5	46.43	-10.17	36.26	66.02	-19.59	46.02	-9.76	41	125	V	2
945.0624	8.8	Pk	23.9	10.5	43.2	-10.17	33.03	66.02	-22.82	46.02	-12.99	175	324	H	2
945.0529	11.61	Pk	23.9	10.5	46.01	-10.17	35.84	66.02	-20.01	46.02	-10.18	5	166	H	3
945.0674	12.69	Pk	23.9	10.5	47.09	-10.17	36.92	66.02	-18.93	46.02	-9.1	76	122	V	3
Notes:															
1 - X- Axis (Laying Flat) 315MHz															
2 - Z- Axis (Straight Up) 315MHz															
3 - Y- Axis (Sideways) 315MHz															
Pk - Peak detector															

Below 1GHz all measurement data was collected with transmitter set to mode #1 and duty cycle for mode #5. Because the drive level for mode #1 is much higher then for mode #5 it was considered as worst case.

Table 40 - Radiated Emissions Data Points 315MHz – Above 1GHz

Marker No.	Test Frequency (GHz)	Meter Reading (dBuV)	Detector	Antenna Factor dB/m	Path Factor dB	Peak Level dBuV/m	DC Factor dB	Average Level with DB dBuV/m	Peak Limit dBuV/m	Peak Margin dB	Average Limit dBuV/m	Average Margin dB	Azimuth [Degs]	Height [cm]	Polarity
3	1.26	75.88	Pk	28.9	-56.21	48.57	-10.17	38.4	74	-25.43	54	-15.6	0-360	100	H
25	1.26	76.59	Pk	28.9	-56.21	49.28	-10.17	39.11	74	-24.72	54	-14.89	0-360	100	V
6	1.575	85.09	Pk	28.2	-54.64	58.65	-10.17	48.48	74	-15.35	54	-5.52	350	179	H
44	1.575	78.46	Pk	28.2	-54.64	52.02	-10.17	41.85	74	-21.98	54	-12.15	77	254	V
8	1.89	78.94	Pk	31.3	-53.57	56.67	-10.17	46.5	74	-17.33	54	-7.5	49	123	H
27	1.891	69.81	Pk	31.3	-53.58	47.53	-10.17	37.36	74	-26.47	54	-16.64	0-360	150	V
11	2.205	74.4	Pk	21.8	-52.46	43.74	-10.17	33.57	74	-30.26	54	-20.43	0-360	150	H
30	2.205	69.86	Pk	21.8	-52.46	39.2	-10.17	29.03	74	-34.8	54	-24.97	0-360	100	V
14	2.5202	81.07	Pk	22.1	-51.82	51.35	-10.17	41.18	74	-22.65	54	-12.82	33	209	H
33	2.52	76.21	Pk	22.1	-51.82	46.49	-10.17	36.32	74	-27.51	54	-17.68	0-360	150	V
17	2.835	75.11	Pk	22.3	-50.62	46.79	-10.17	36.62	74	-27.21	54	-17.38	0-360	99	H
36	2.835	66.71	Pk	22.3	-50.62	38.39	-10.17	28.22	74	-35.61	54	-25.78	0-360	100	V
20	3.1502	81.97	Pk	22.9	-50.81	54.06	-10.17	43.89	74	-19.94	54	-10.11	65	127	H
39	3.151	72.5	Pk	22.9	-50.83	44.57	-10.17	34.4	74	-29.43	54	-19.6	0-360	100	V
9	2.024	64.39	Pk	21.2	-53.29	32.3	0	-	74	-41.7	54	-21.7	0-360	150	H
45	3.41	69.97	Pk	23.5	-50.66	42.81	0	-	74	-31.19	54	-11.19	0-360	99	H
46	3.465	74.39	Pk	23.5	-50.99	46.9	0	-	74	-27.1	54	-7.1	0-360	99	H
47	3.721	67.86	Pk	23.6	-49.9	41.56	0	-	74	-32.44	54	-12.44	0-360	150	H
48	3.781	71.77	Pk	24	-51.46	44.31	0	-	74	-29.69	54	-9.69	0-360	150	H
49	3.876	68.41	Pk	23.9	-51.15	41.16	0	-	74	-32.84	54	-12.84	0-360	150	H
50	3.938	68.86	Pk	24	-50.95	41.91	0	-	74	-32.09	54	-12.09	0-360	99	H
28	2.023	72.09	Pk	21.2	-53.27	40.02	0	-	74	-33.98	54	-13.98	0-360	150	V
Pk - Peak detector															

For above 1GHz all measurement data was collected with transmitter set to mode #8 (higher output power) and duty cycle from mode #5. Because all emission levels are under the limit it was considered worst case and it was considered not necessary to re-do measurement with transmitter set to mode #5.