



MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*

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February 18, 2013

Alarm.com
8150 Leesburg Pike, Suite 1400
Vienna, VA 22182

Dear David Goldfarb,

Enclosed is the EMC Wireless test report for Class II Permissive Change compliance testing of the Alarm.com, Image Sensor Daughterboard - Model: ADC-IS20-EVD as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15, Subpart C and RSS-210, Issue 8, Dec. 2010 for Intentional Radiators.

Thank you for using the services of MET Laboratories, Inc. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,
MET LABORATORIES, INC.

Jennifer Warnell
Documentation Department

Reference: (\Alarm.com\EMC35741B-FCC247 Rev. 1)

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Electromagnetic Compatibility Criteria Class II Permissive Change Test Report

for the

Alarm.com
Image Sensor Daughterboard - Model: ADC-IS20-EVD

Tested under
the FCC Certification Rules
contained in
15.247 Subpart C & RSS-210, Issue 8, Dec. 2010
for Intentional Radiators

MET Report: EMC35741B-FCC247 Rev. 1

February 18, 2013

Prepared For:

Alarm.com
8150 Leesburg Pike, Suite 1400
Vienna, VA 22182

Prepared By:
MET Laboratories, Inc.
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15.247 Subpart C & RSS-210, Issue 8, Dec. 2010
for Intentional Radiators



Benjamin Taylor, Project Engineer
Electromagnetic Compatibility Lab



Jennifer Warnell
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rules Part 15.249 and Industry Canada standard RSS-210, Issue 8, December 2010 under normal use and maintenance.



Asad Bajwa, Director
Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	February 12, 2013	Initial Issue.
1	February 18, 2013	Revised to reflect engineer corrections.

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List of Terms and Abbreviations

AC	Alternating Current
ACF	Antenna Correction Factor
Cal	Calibration
<i>d</i>	Measurement Distance
dB	Decibels
dB μ A	Decibels above one microamp
dB μ V	Decibels above one microvolt
dB μ A/m	Decibels above one microamp per meter
dB μ V/m	Decibels above one microvolt per meter
DC	Direct Current
E	Electric Field
DSL	Digital Subscriber Line
ESD	Electrostatic Discharge
EUT	Equipment Under Test
<i>f</i>	Frequency
FCC	Federal Communications Commission
GRP	Ground Reference Plane
H	Magnetic Field
HCP	Horizontal Coupling Plane
Hz	Hertz
IEC	International Electrotechnical Commission
kHz	kilohertz
kPa	kilopascal
kV	kilovolt
LISN	Line Impedance Stabilization Network
MHz	Megahertz
μ H	microhenry
μ	microfarad
μ s	microseconds
NEBS	Network Equipment-Building System
PRF	Pulse Repetition Frequency
RF	Radio Frequency
RMS	Root-Mean-Square
TWT	Traveling Wave Tube
V/m	Volts per meter
VCP	Vertical Coupling Plane

I. Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Image Sensor Daughterboard - Model: ADC-IS20-EVD, with the requirements of Part 15, §15.247. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the Image Sensor Daughterboard - Model: ADC-IS20-EVD. Alarm.com should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Image Sensor Daughterboard - Model: ADC-IS20-EVD, has been **permanently** discontinued.

B. Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, §15.247, in accordance with Alarm.com, purchase order number T02447. All tests were conducted using measurement procedure ANSI C63.4-2003.

FCC Reference	Canada Reference	Description	Results
§15.247(d), §15.209	RSS-Gen §7.2.5 and RSS-210 A2.0	Harmonics and Spurious Emissions	Compliant
Title 47 of the CFR, Part 15 §15.247(i)	RSS-Gen(5.6)	Maximum Permissible Exposure (MPE)	Compliant

Table 1. Executive Summary of EMC Part 15.247 Compliance Testing

Note: This radio's testing was conducted to support a Class II Permissive Change; being collocated with FCC IDs YL6-143200H5V4, YL6-143200C5V4, and YL6-143200T5V4.

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Alarm.com to perform testing on the Image Sensor Daughterboard - Model: ADC-IS20-EVD, under Alarm.com's purchase order number T02447.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Alarm.com, Image Sensor Daughterboard - Model: ADC-IS20-EVD.

The results obtained relate only to the item(s) tested.

Filing Option:	Class II Permissive Change	
Model(s) Tested:	Image Sensor Daughterboard - Model: ADC-IS20-EVD collocated with ADC-200H-EVD, ADC-200C-EVD, and ADC-200T-EVD.	
Model(s) Covered:	Image Sensor Daughterboard - Model: ADC-IS20-EVD collocated with ADC-200H-EVD, ADC-200C-EVD, and ADC-200T-EVD.	
EUT Specifications:	Primary Power: 120 VAC, 60 Hz	
	FCC ID: YL6-143IS205V4 IC: 9111A-143IS205V4	
	Type of Modulations:	O-QPSK
	Equipment Code:	DTS
	EUT Frequency Ranges:	912 – 924 MHz
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35° C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	Benjamin Taylor	
Report Date(s):	February 18, 2013	

Table 2. EUT Summary Table

B. References

CFR 47, Part 15, Subpart C	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies
CFR 47, Part 15, Subpart B	Electromagnetic Compatibility: Criteria for Radio Frequency Devices
RSS-210, Issue 8, Dec. 2010	Low-power Licence-exempt Radiocommunications Devices (All Frequency Bands): Category I Equipment
RSS-GEN, Issue 3, Dec. 2010	General Requirements and Information for the Certification of Radio Apparatus
ICES-003, Issue 4 February 2004	Electromagnetic Compatibility: Criteria for Radio Frequency Devices
ANSI C63.4:2003	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ISO/IEC 17025:2005	General Requirements for the Competence of Testing and Calibration Laboratories
ANSI C63.10-2009	American National Standard for Testing Unlicensed Wireless Devices

Table 3. References

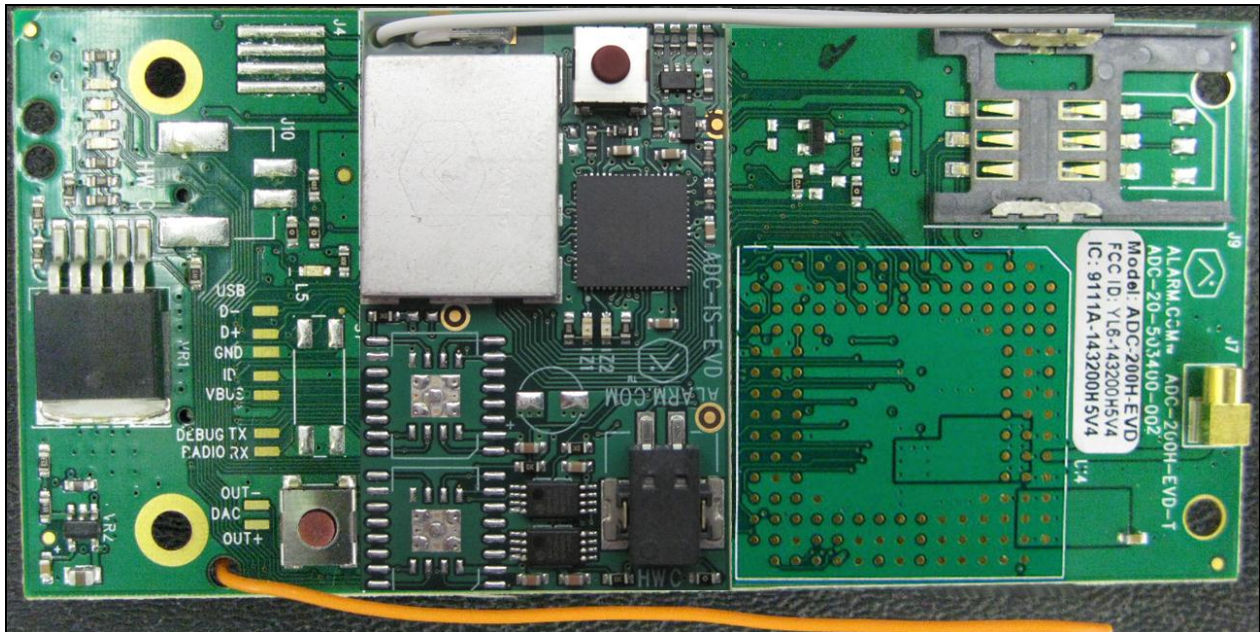
C. Test Site

All testing was performed at MET Laboratories, Inc., 914 W. Patapsco Ave., Baltimore, MD 21230. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

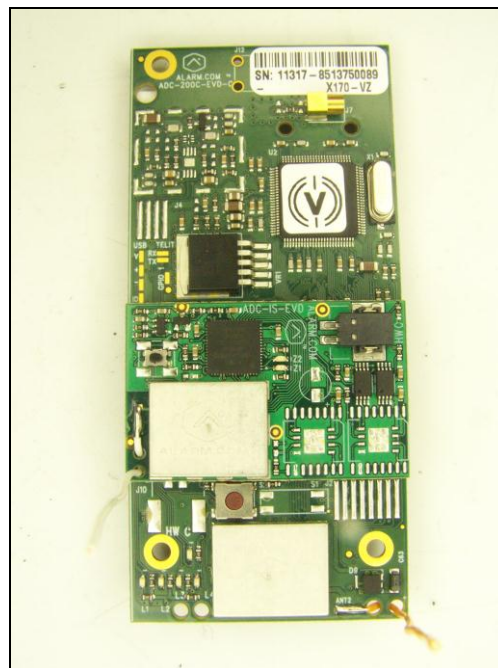
Radiated Emissions measurements were performed in a 3 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories.

D. Description of Test Sample

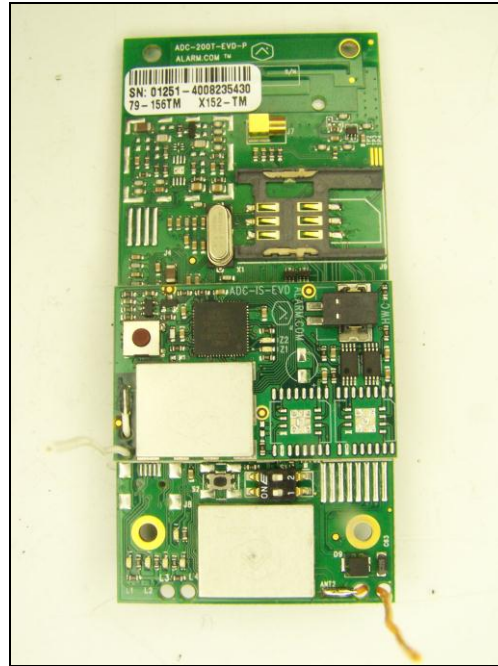
The Image Sensor Daughterboard - Model: ADC-IS20-EVD, was set to transmit continuously while its collocated radio of either the ADC-200H-EVD, ADC-200C-EVD, and ADC-200T-EVD was also set to continuously transmit. Testing was repeated for low, mid, and high channel of the ADC-IS20-EVD.



Photograph 1. Image Sensor Daughterboard - Model: ADC-IS20-EVD, Collocation with FCC ID: YL6-143200H5V4



Photograph 2. Image Sensor Daughterboard - Model: ADC-IS20-EVD, Collocation with FCC ID: YL6-143200C5V4



Photograph 3. Image Sensor Daughterboard - Model: ADC-IS20-EVD, Collocation with FCC ID: YL6-143200T5V4

E. Equipment Configuration

The EUT was set up as outlined in **Error! Reference source not found.**, Block Diagram of Test Setup. All cards, racks, etc., incorporated as part of the EUT is included in the following list.

Ref. ID	Name / Description	Model Number	Part Number	Serial Number	Revision
A	Wireless Modules, tested for collocation	ADC-IS20-EVD collocated with ADC-200H-EVD, ADC-200C-EVD, ADC-200T-EVD	N/A	N/A	2

Table 4. Equipment Configuration

F. Support Equipment

Support equipment necessary for the operation and testing of the EUT is included in the following list.

Ref. ID	Name / Description	Manufacturer	Model Number
B	Power Connector Board	Alarm.com	N/A

Table 5. Support Equipment

G. Ports and Cabling Information

Ref. ID	Port Name on EUT	Cable Description	Qty.	Length (m)	Shielded (Y/N)	Termination Point
1	DC Input	Connector to power [A] Image Sensor Daughterboard	N/A	N/A	N/A	N/A
2	DC Input	Power to [B] Power Connector Board	N/A	N/A	N/A	N/A

Table 6. Ports and Cabling Information

H. Mode of Operation

The ADC-IS20-EVD was set to transmit continuously on its low, mid, and high channel as appropriate for testing, while its collocated radio modules (ADC-200H-EVD, ADC-200C-EVD, ADC-200T-EVD) continuously transmitted on their one channel.

I. Method of Monitoring EUT Operation

The unit is functioning correctly if at least one of the LED's on the device is on.

If the Green LED is on the module is in RX mode.

If the Green and Red LED are on the module is in TX mode.

J. Modifications

a) Modifications to EUT

No modifications were made to the EUT.

b) Modifications to Test Standard

No modifications were made to the test standard.

K. Disposition of EUT

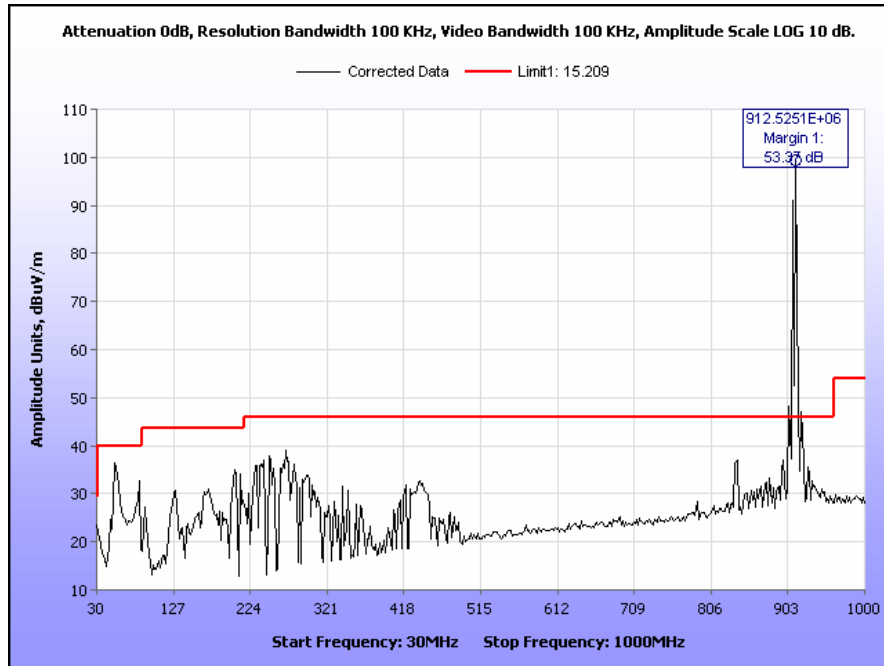
The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Alarm.com upon completion of testing.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

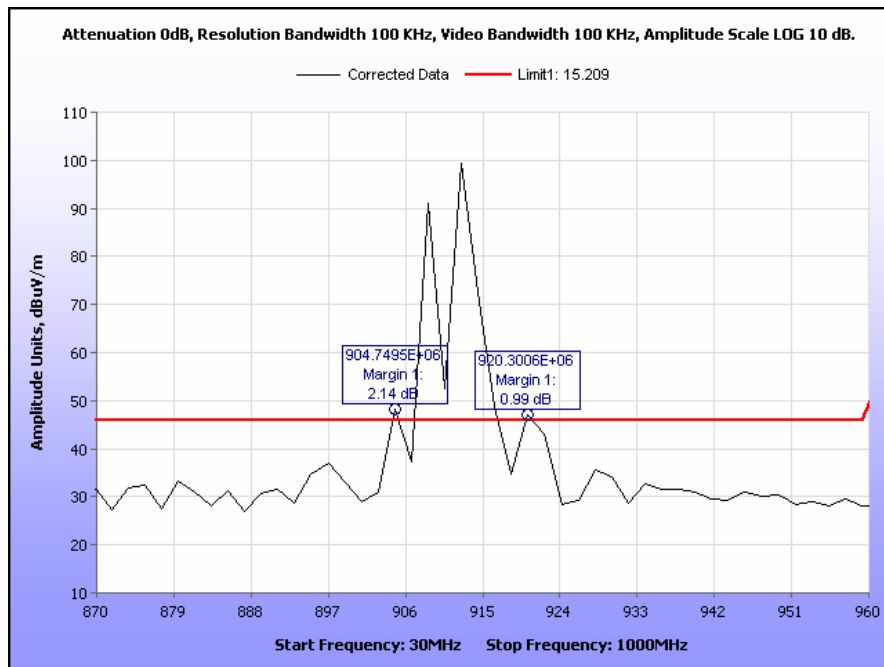
Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.249(a)(d) Harmonics and Spurious Emissions Requirements

- Test Requirements:** Harmonics originating from devices that operate in the 902-928 MHz band shall meet the 500 microvolts/meter limit (i.e. 54 dBuV/m) with an average detector. In addition, emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.
- Test Procedure:** Measurements were performed with the EUT rotated 360 degrees and varying the adjustable antenna mast with 1 m to 4 m height to determine worst case orientation for maximum emissions. Emissions below 1 GHz were performed with the antenna placed 3m away from EUT. For above 1 GHz, the measuring antenna was placed 1m away. Testing was performed as necessary for collocation of the two radio modules; the radios were programmed to transmit simultaneously during testing.
- Test Results:** The EUT is compliant with the harmonics and Spurious Emissions Requirements of § 15.249(a)(d). For spurious emissions the lesser attenuation was the 15.209 limits.
- Test Engineer(s):** Ben Taylor
- Test Date(s):** 02/04/13

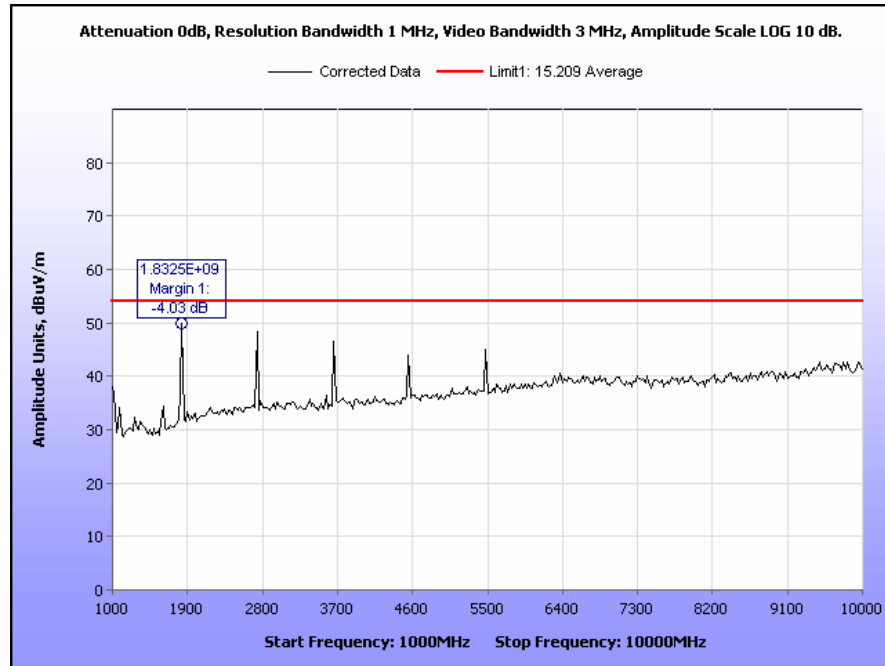


Plot 1. Radiated Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Co-located with FCC ID: YL6-143200H5V4

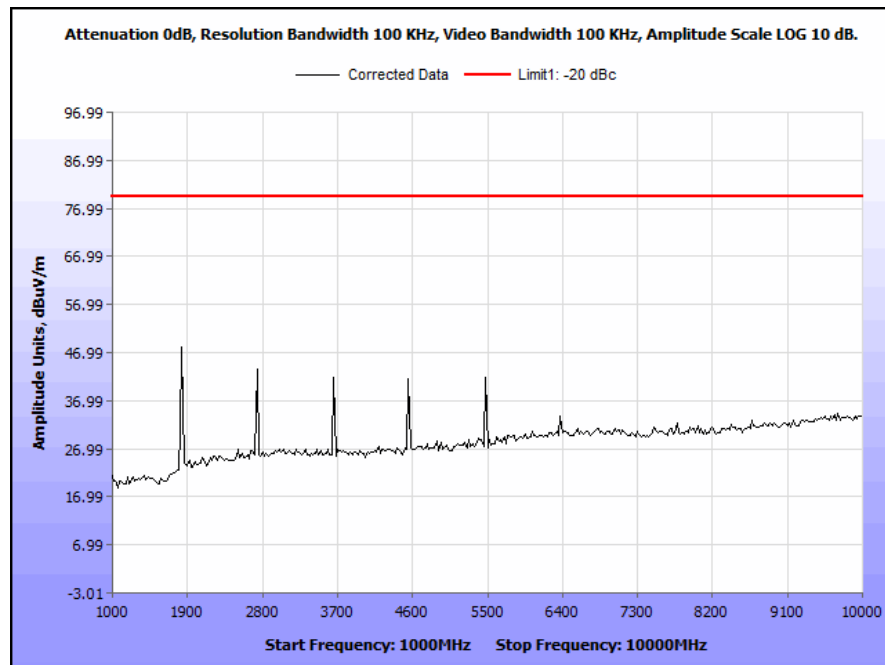


Plot 2. Transmitter Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Zoomed, Co-located with FCC ID: YL6-143200H5V4

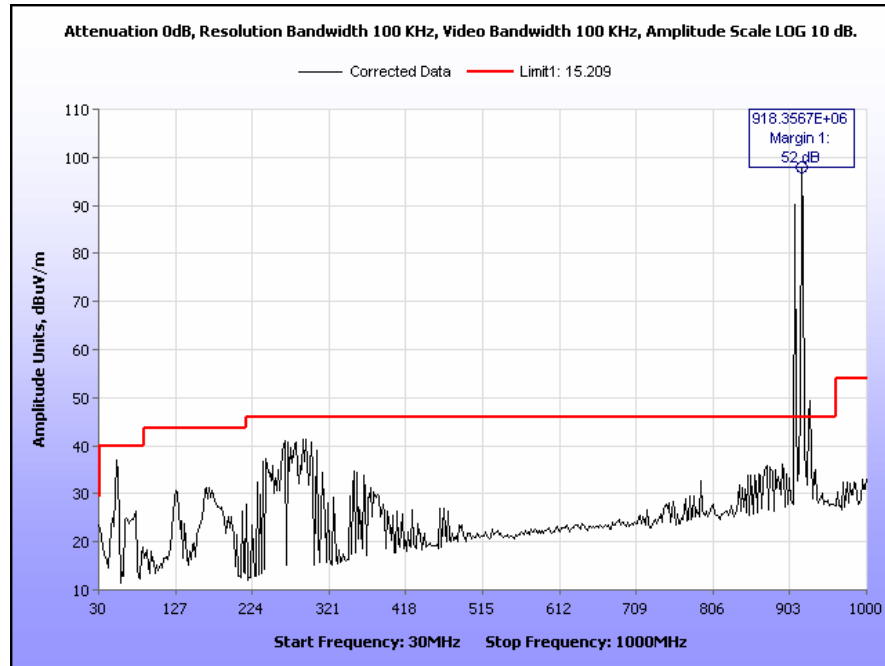
Note: The high emissions are the fundamentals of the two radios, and the spurs (with markers) are in-band.



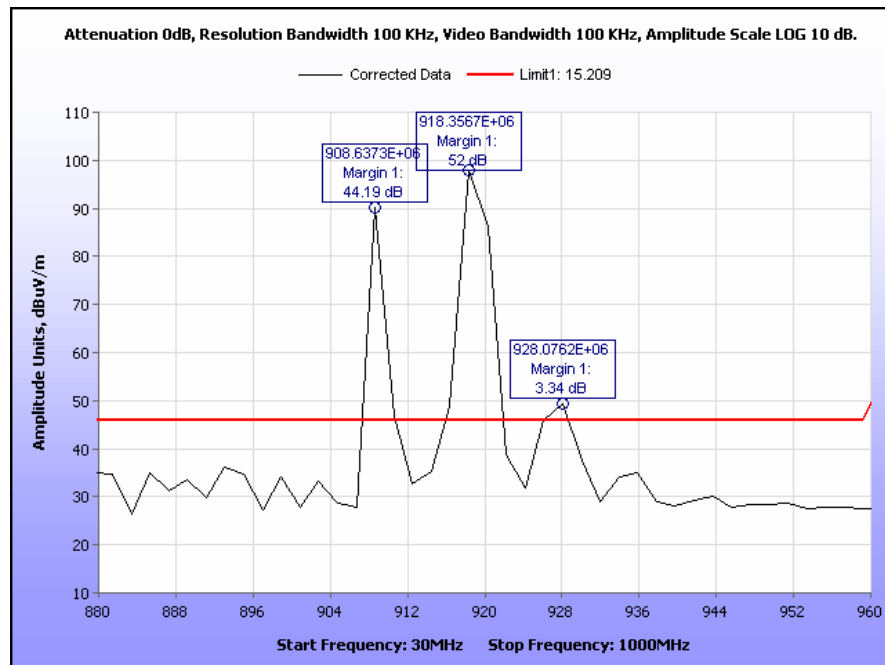
Plot 3. Transmitter Spurious Emissions, Low Channel, 1 GHz – 10 GHz, Peak under Average, Co-located with FCC ID: YL6-143200H5V4



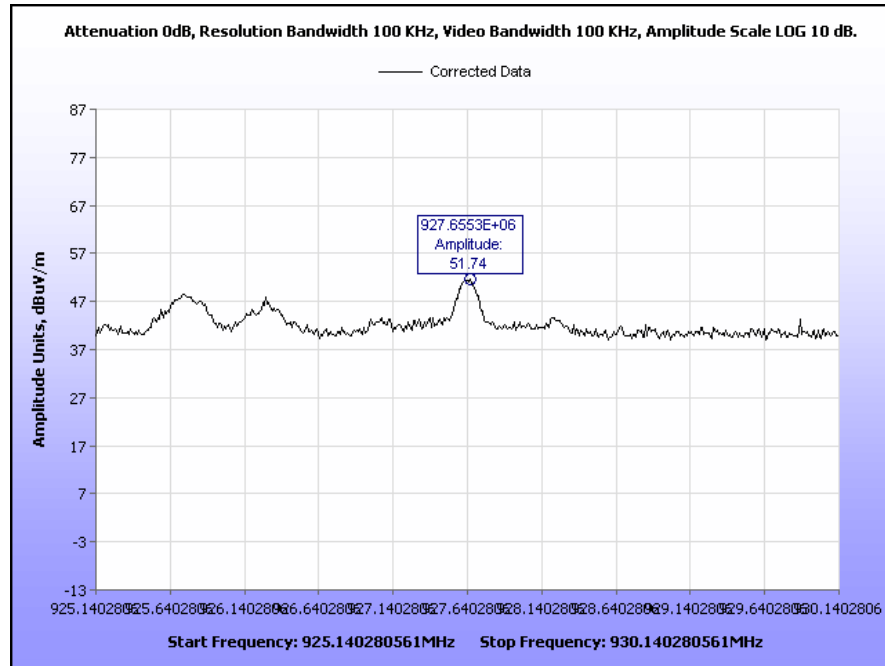
Plot 4. Transmitter Spurious Emissions, Low Channel, Co-located with FCC ID: YL6-143200H5V4



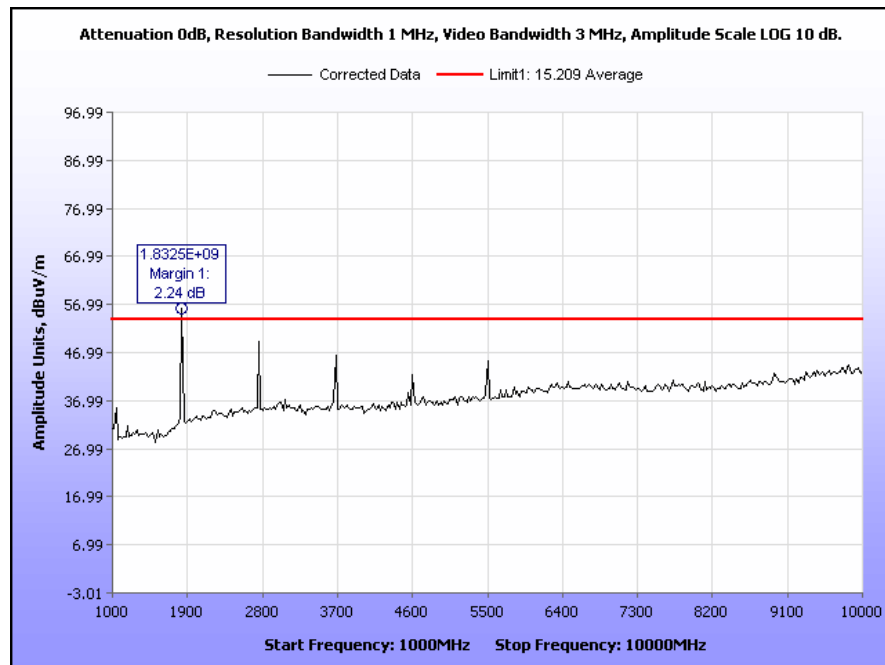
Plot 5. Radiated Spurious Emissions, Mid Channel, 30 MHz – 1 GHz, Co-located with FCC ID: YL6-143200H5V4



Plot 6. Transmitter Spurious Emissions, Mid Channel, 30 MHz – 1 GHz, Zoomed, Co-located with FCC ID: YL6-143200H5V4

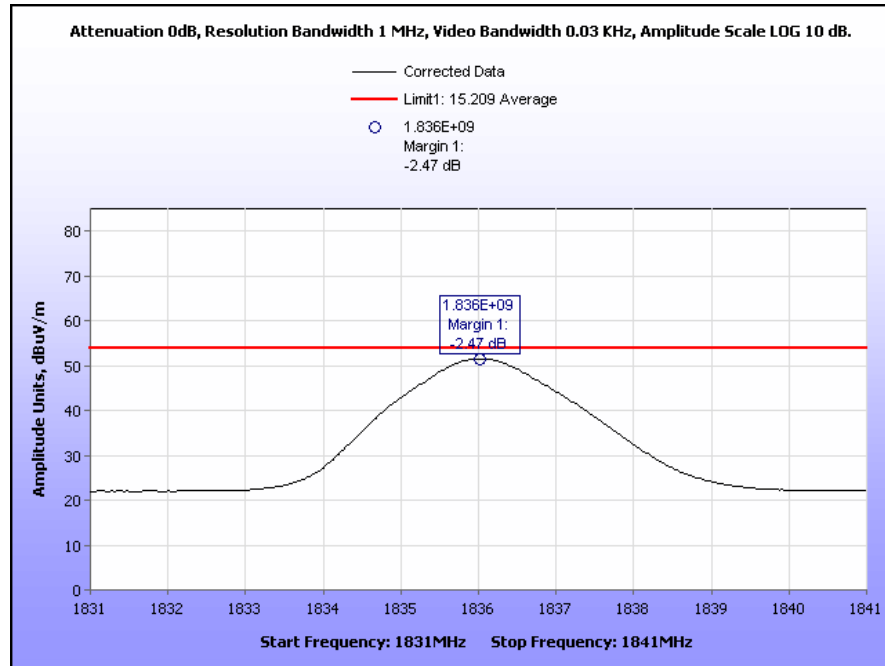


Plot 7. Transmitter Spurious Emissions, Mid Channel, Co-located with FCC ID: YL6-143200H5V4

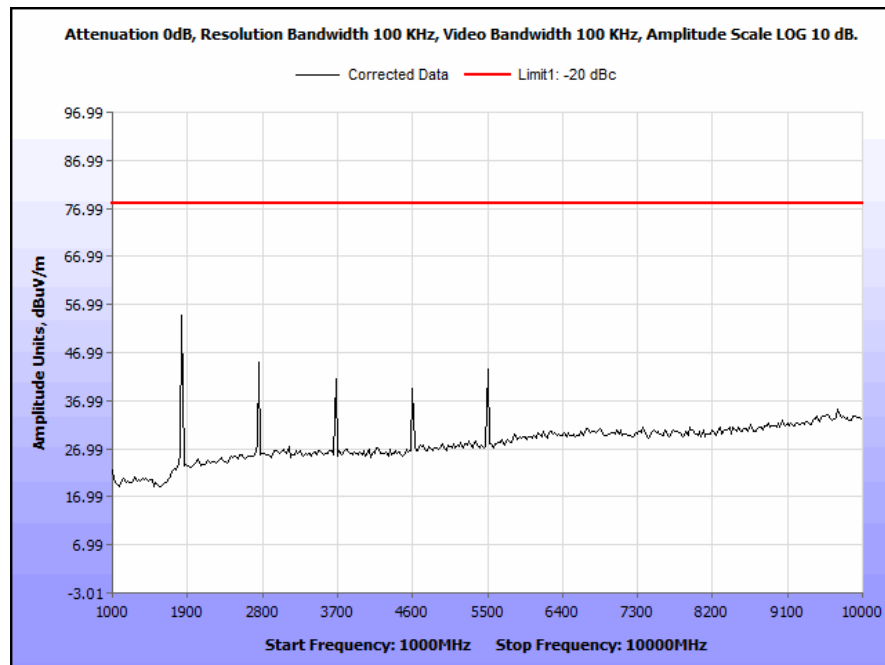


Plot 8. Transmitter Spurious Emissions, Mid Channel, 1 GHz – 10 GHz, Peak under Average

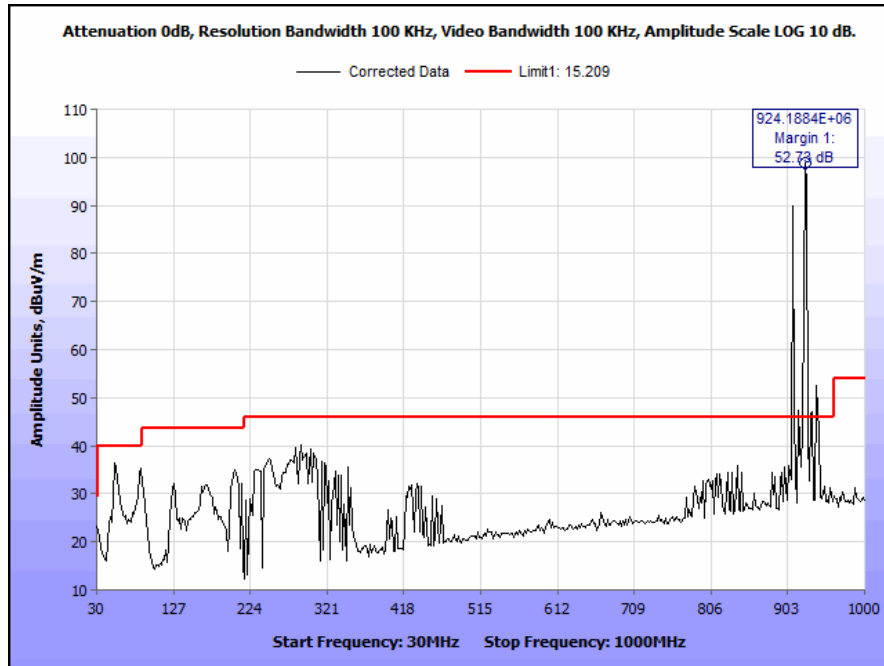
Note: with the exception of those denoted with markers; measured separately below, Co-located with FCC ID: YL6-143200H5V4



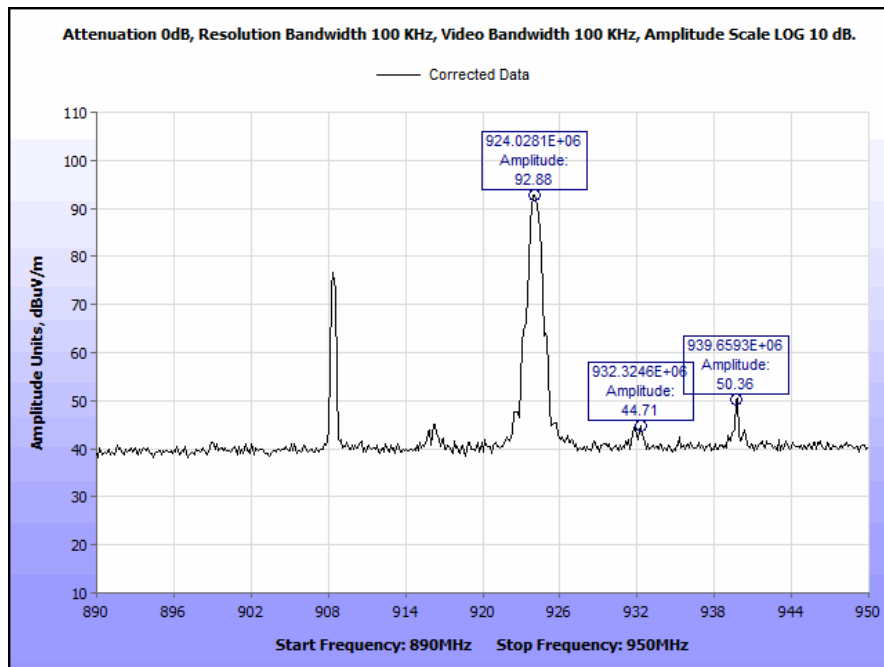
Plot 9. Transmitter Spurious Emissions, Mid Channel, Average, Co-located with FCC ID: YL6-143200H5V4



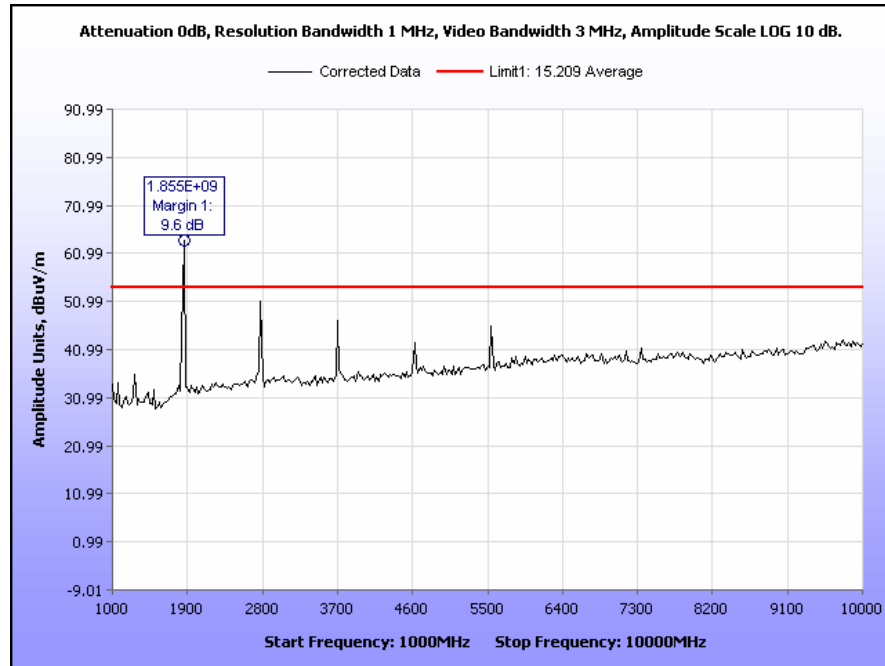
Plot 10. Transmitter Spurious Emissions, Mid Channel, Co-located with FCC ID: YL6-143200H5V4



Plot 11. Radiated Spurious Emissions, High Channel, 30 MHz – 1 GHz, Co-located with FCC ID: YL6-143200H5V4

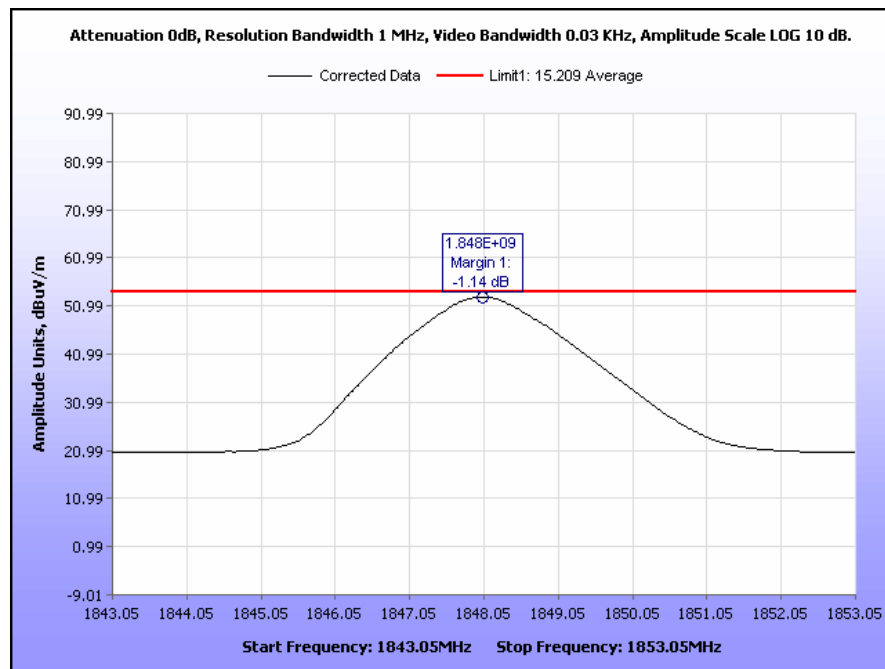


Plot 12. Transmitter Spurious Emissions, High Channel, Co-located with FCC ID: YL6-143200H5V4

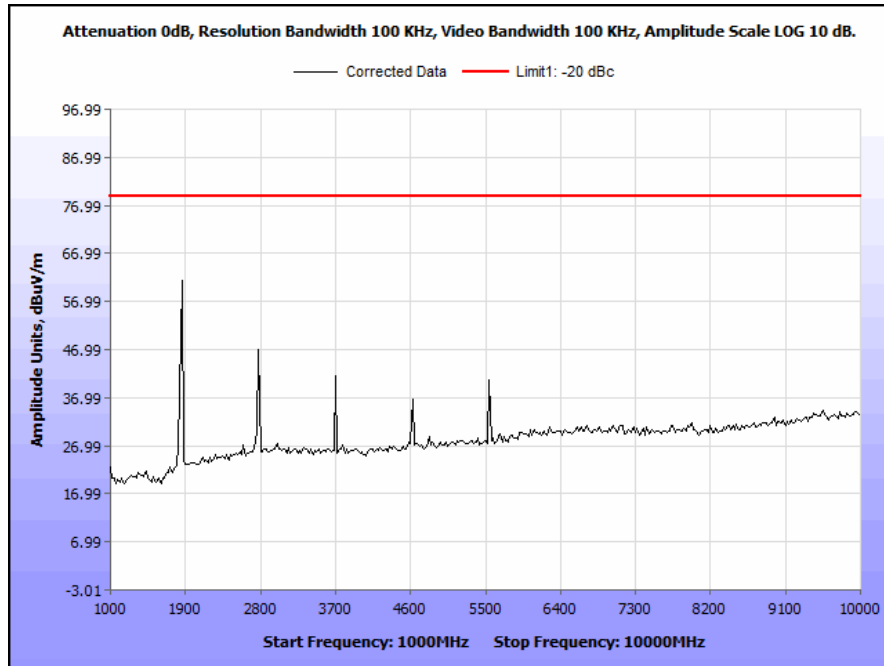


Plot 13. Transmitter Spurious Emissions, High Channel, 1 GHz – 10 GHz, Peak under Average

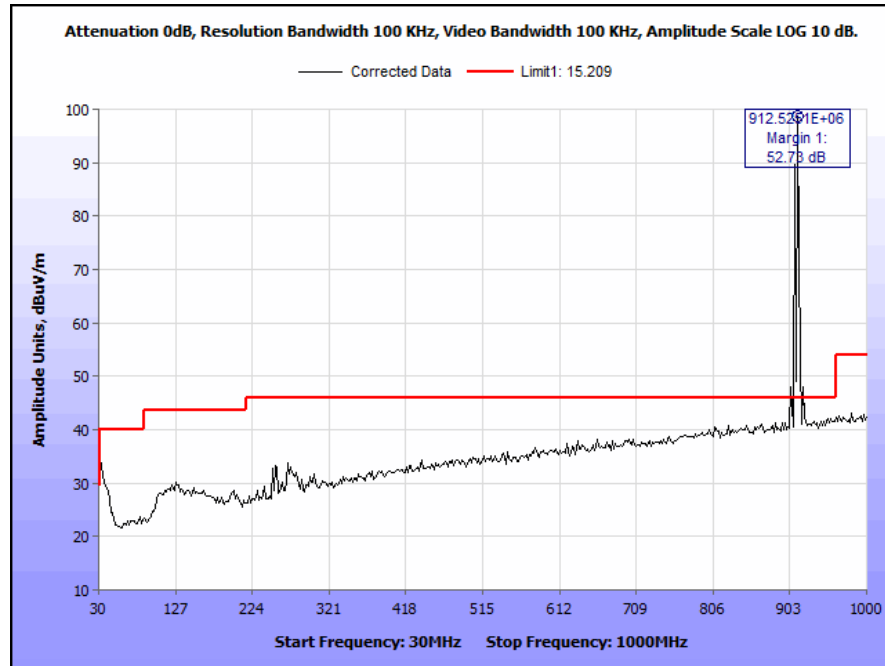
Note: with the exception of those denoted with markers; measured separately below, Co-located with FCC ID: YL6-143200H5V4



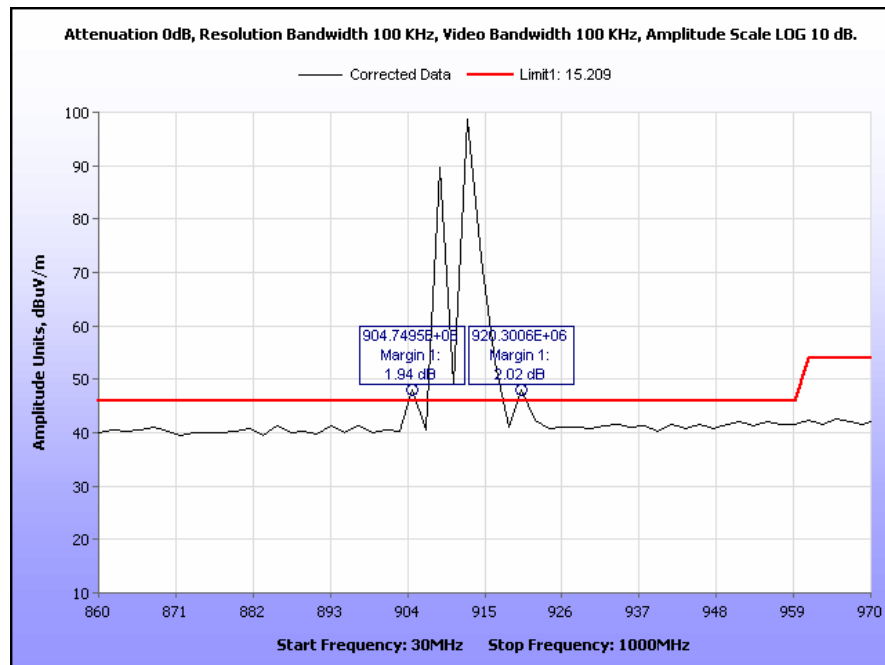
Plot 14. Transmitter Spurious Emissions, High Channel, Average, Co-located with FCC ID: YL6-143200H5V4



Plot 15. Transmitter Spurious Emissions, High Channel, Co-located with FCC ID: YL6-143200H5V4

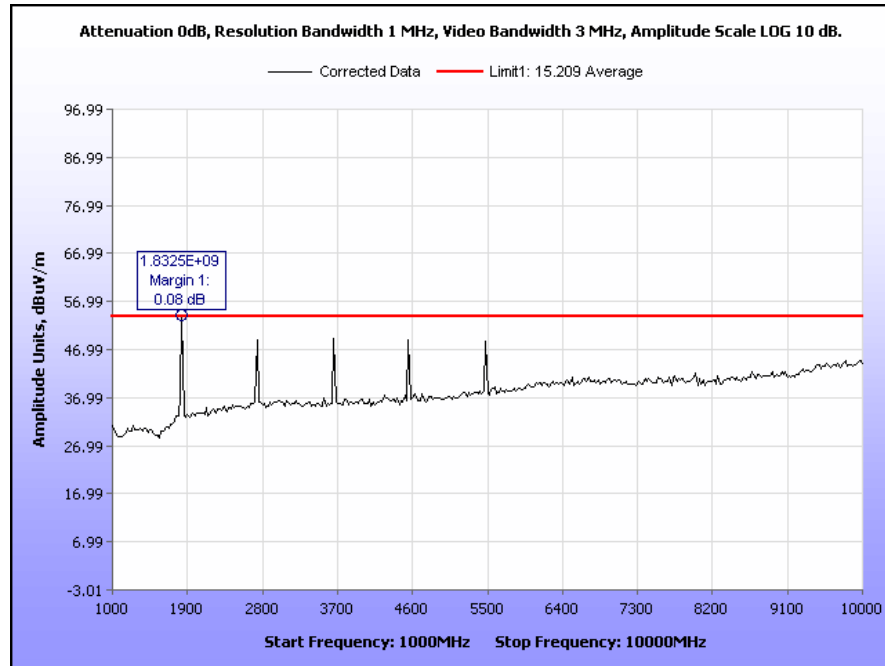


Plot 16. Radiated Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Co-located with FCC ID: YL6-143200C5V4



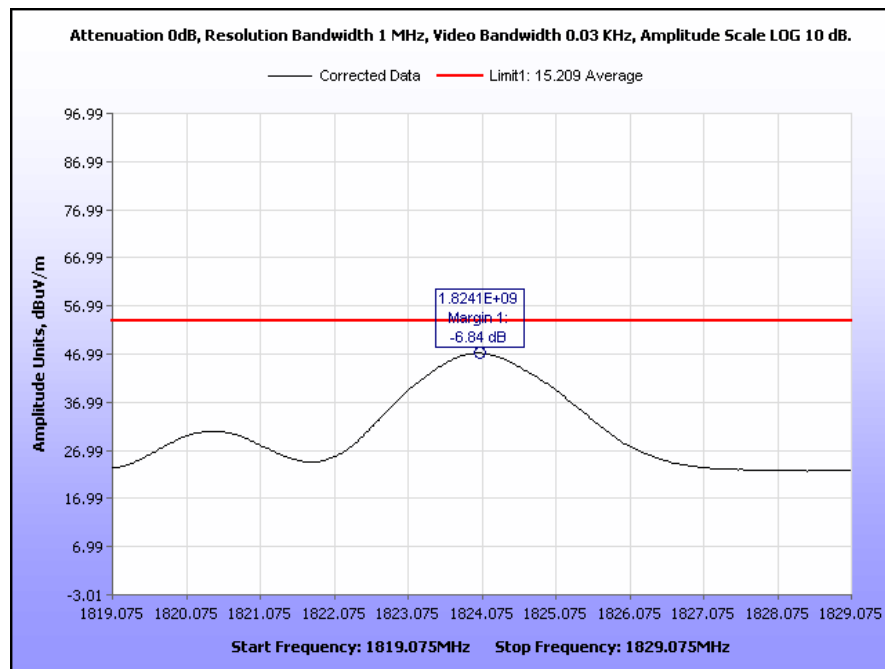
Plot 17. Transmitter Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Zoomed, Co-located with FCC ID: YL6-143200C5V4

Note: The high emissions are the fundamentals of the two radios, and the spurs (with markers) are in-band.

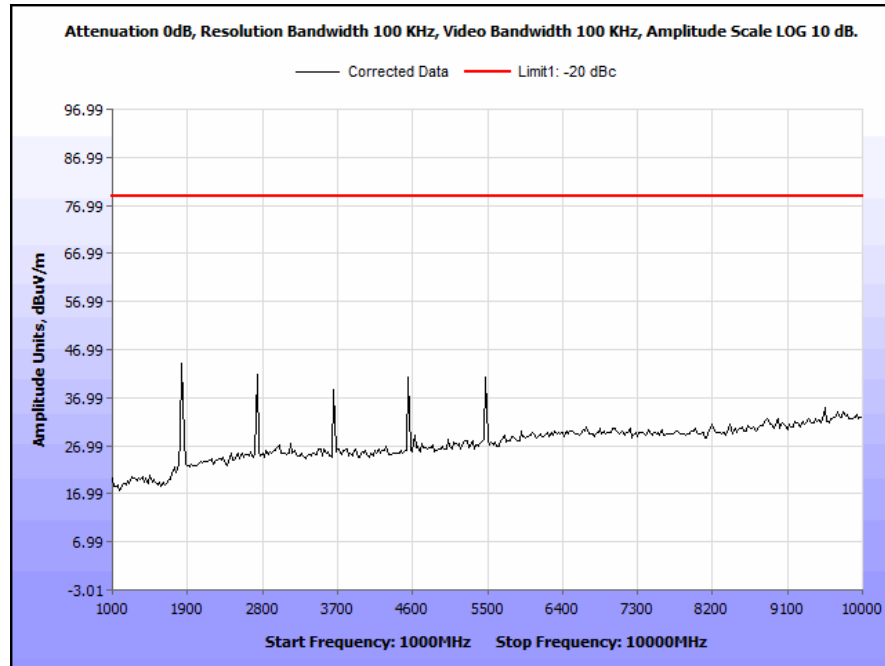


Plot 18. Transmitter Spurious Emissions, Low Channel, 1 GHz – 10 GHz, Peak under Average

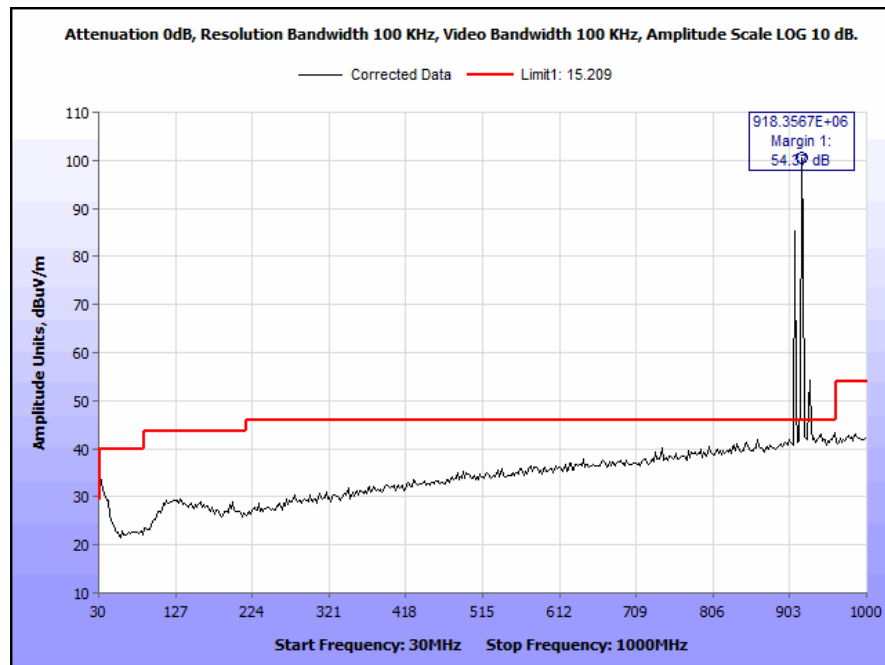
Note: with the exception of those denoted with markers; measured separately below, Co-located with FCC ID: YL6-143200C5V4



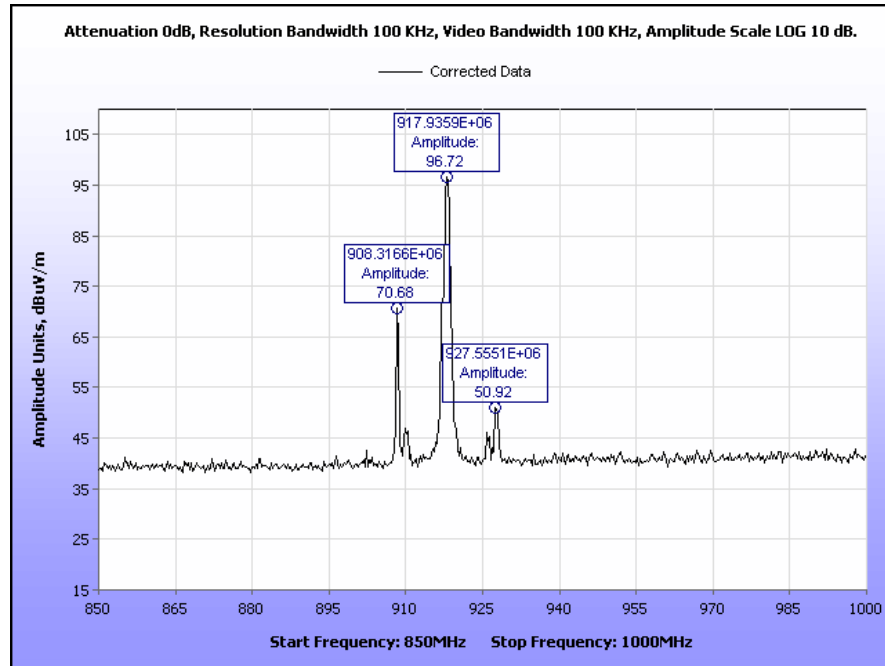
Plot 19. Transmitter Spurious Emissions, Low Channel, Average, Co-located with FCC ID: YL6-143200C5V4



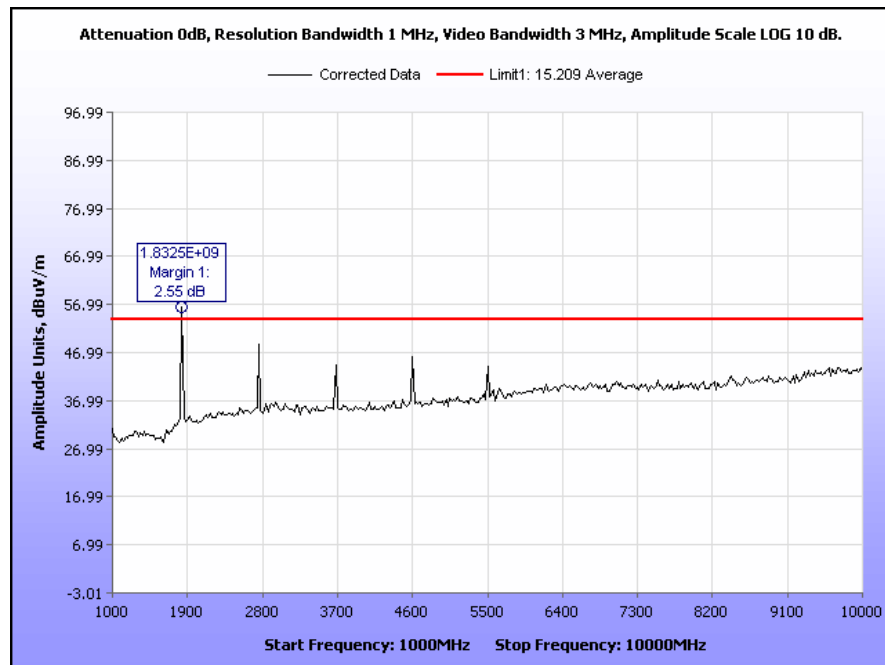
Plot 20. Transmitter Spurious Emissions, Low Channel, Co-located with FCC ID: YL6-143200C5V4



Plot 21. Radiated Spurious Emissions, Mid Channel, 30 MHz – 1 GHz, Co-located with FCC ID: YL6-143200C5V4

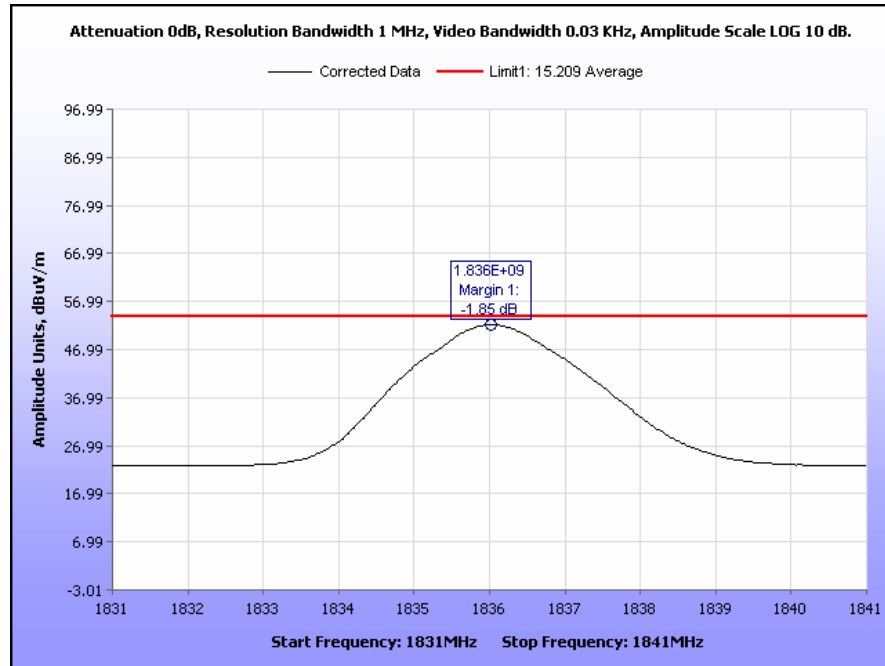


Plot 22. Transmitter Spurious Emissions, Mid Channel, Co-located with FCC ID: YL6-143200C5V4

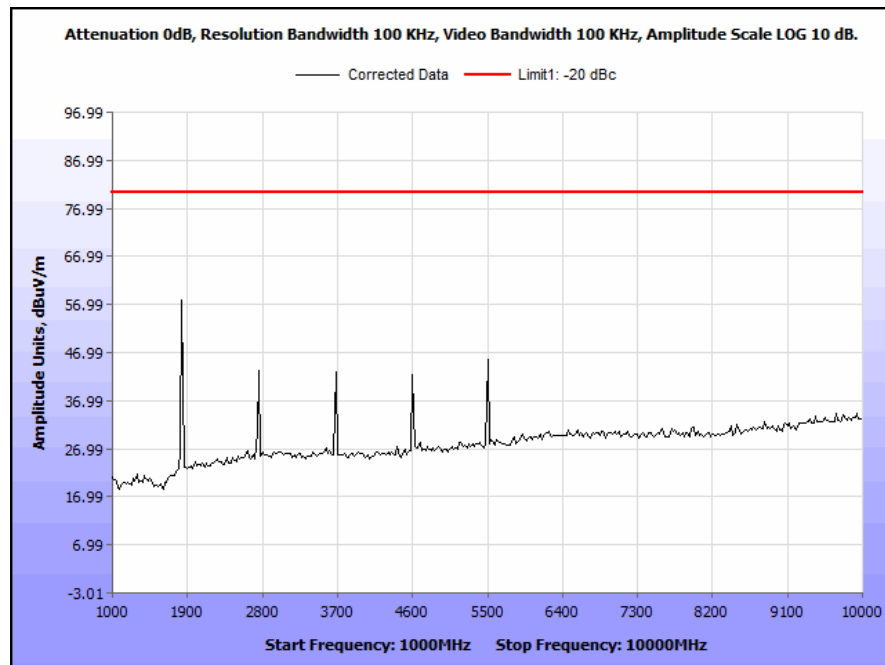


Plot 23. Transmitter Spurious Emissions, Mid Channel, 1 GHz – 10 GHz, Peak under Average

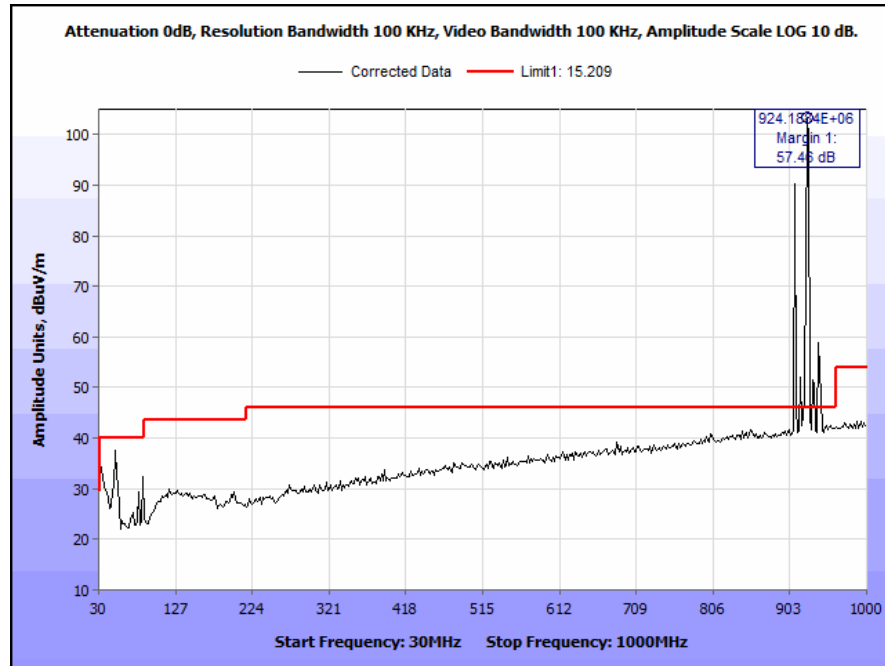
Note: with the exception of those denoted with markers; measured separately below, Co-located with FCC ID: YL6-143200C5V4



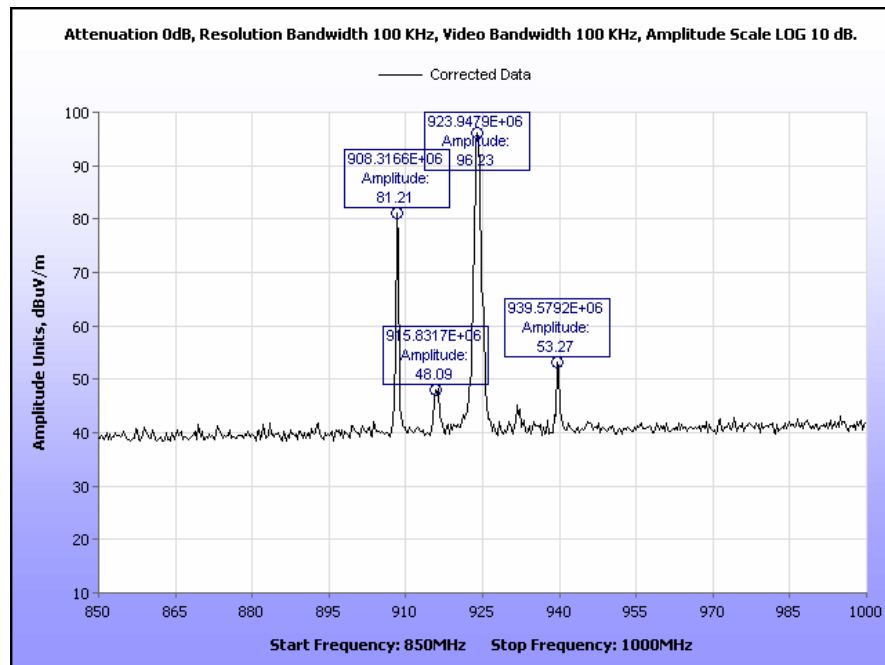
Plot 24. Transmitter Spurious Emissions, Mid Channel, Average, Co-located with FCC ID: YL6-143200C5V4



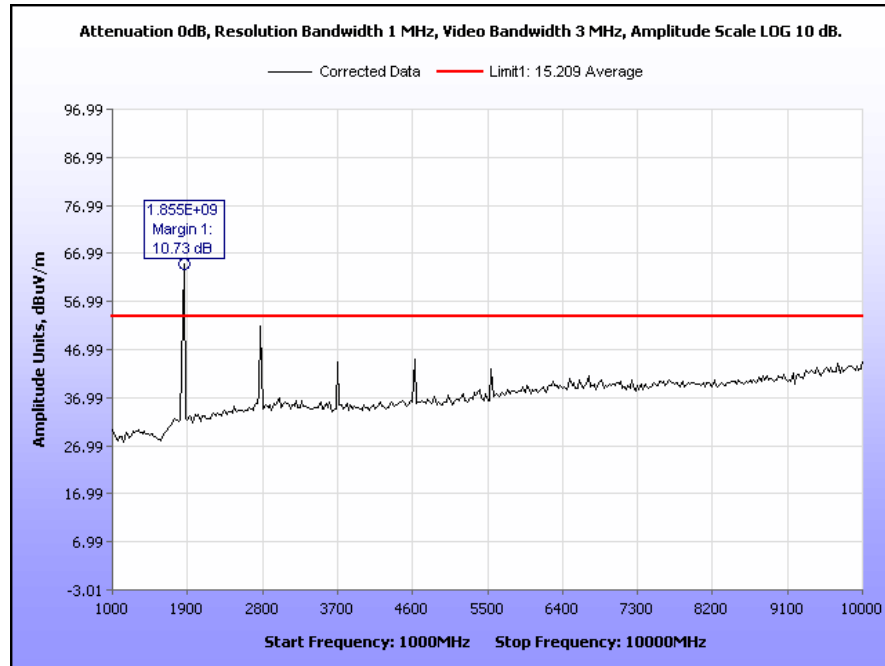
Plot 25. Transmitter Spurious Emissions, Mid Channel, Co-located with FCC ID: YL6-143200C5V4



Plot 26. Radiated Spurious Emissions, High Channel, 30 MHz – 1 GHz, Co-located with FCC ID: YL6-143200C5V4

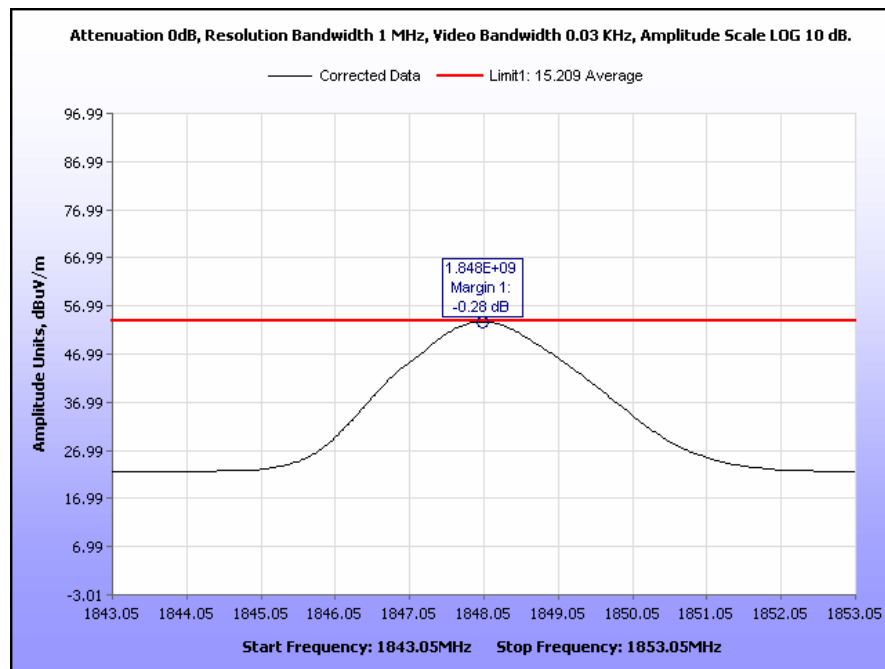


Plot 27. Transmitter Spurious Emissions, High Channel, Co-located with FCC ID: YL6-143200C5V4

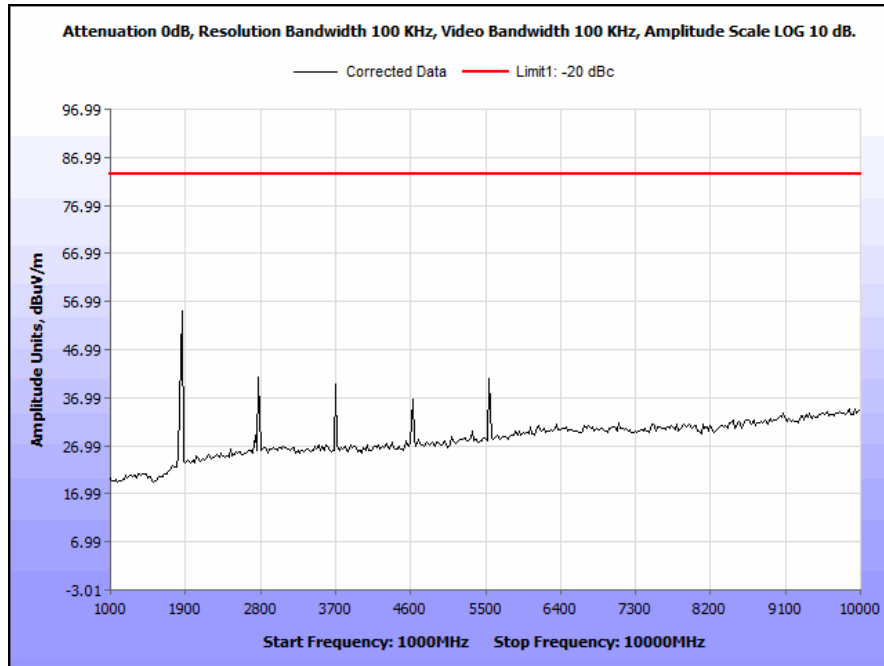


Plot 28. Transmitter Spurious Emissions, High Channel, 1 GHz – 10 GHz, Peak under Average

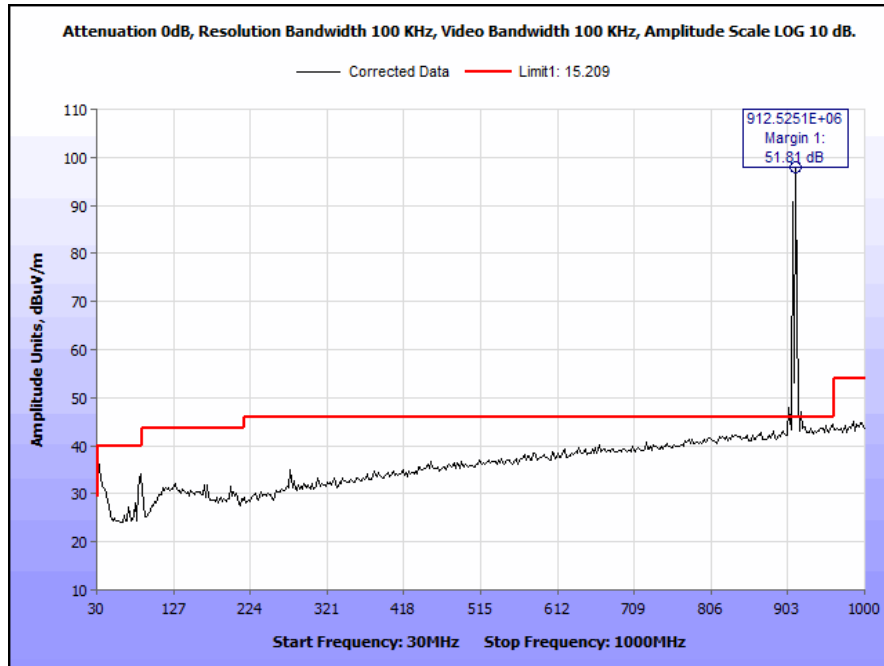
Note: with the exception of those denoted with markers; measured separately below, Co-located with FCC ID: YL6-143200C5V4



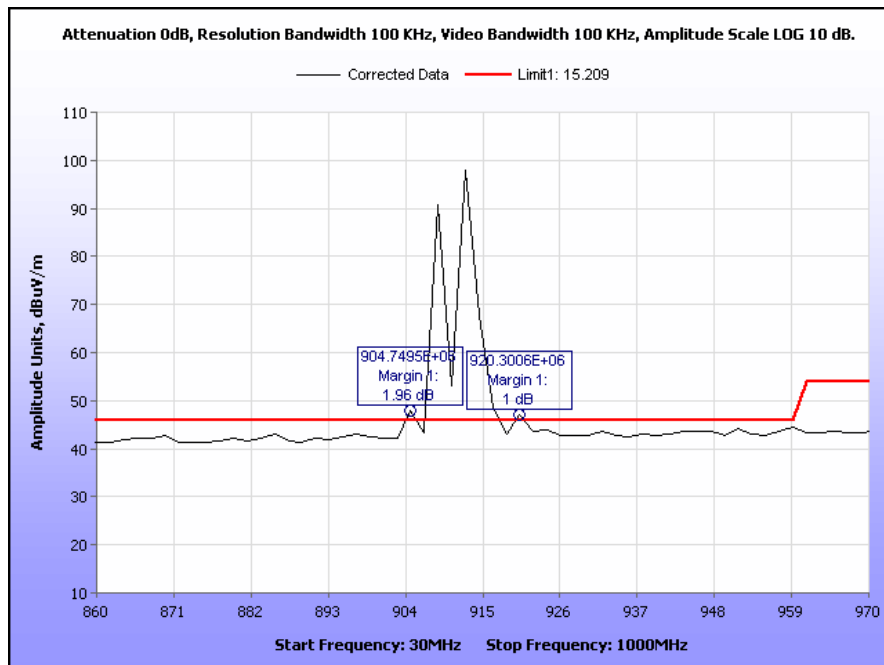
Plot 29. Transmitter Spurious Emissions, High Channel, Average, Co-located with FCC ID: YL6-143200C5V4



Plot 30. Transmitter Spurious Emissions, High Channel, Co-located with FCC ID: YL6-143200C5V4

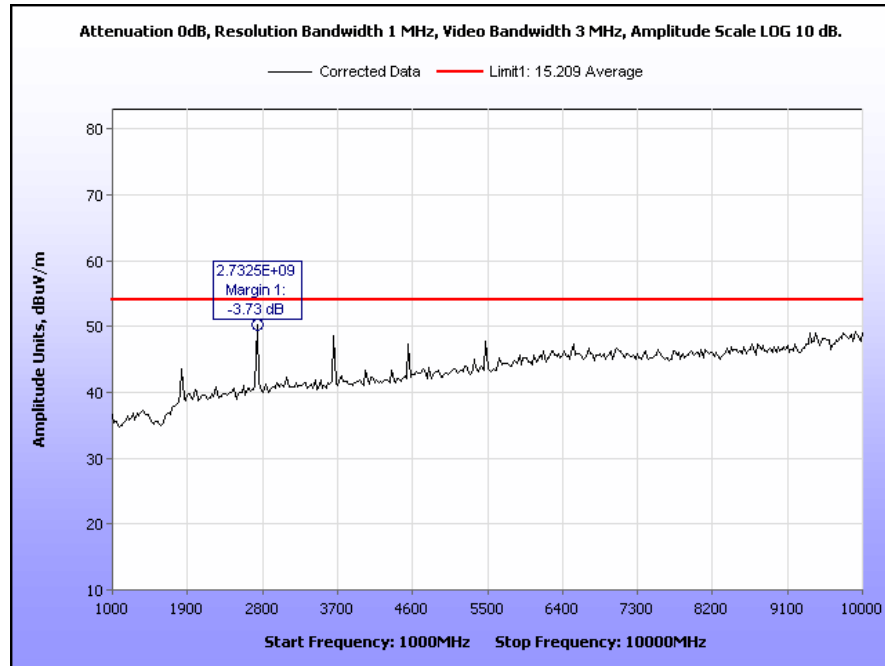


Plot 31. Radiated Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Co-located with FCC ID: YL6-143200T5V4

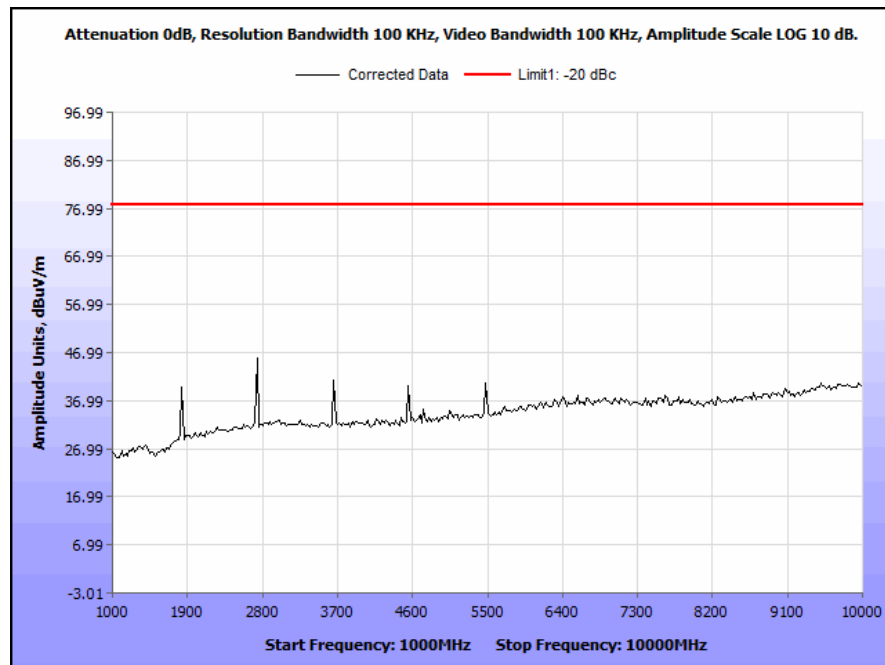


Plot 32. Transmitter Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Zoomed, Co-located with FCC ID: YL6-143200T5V4

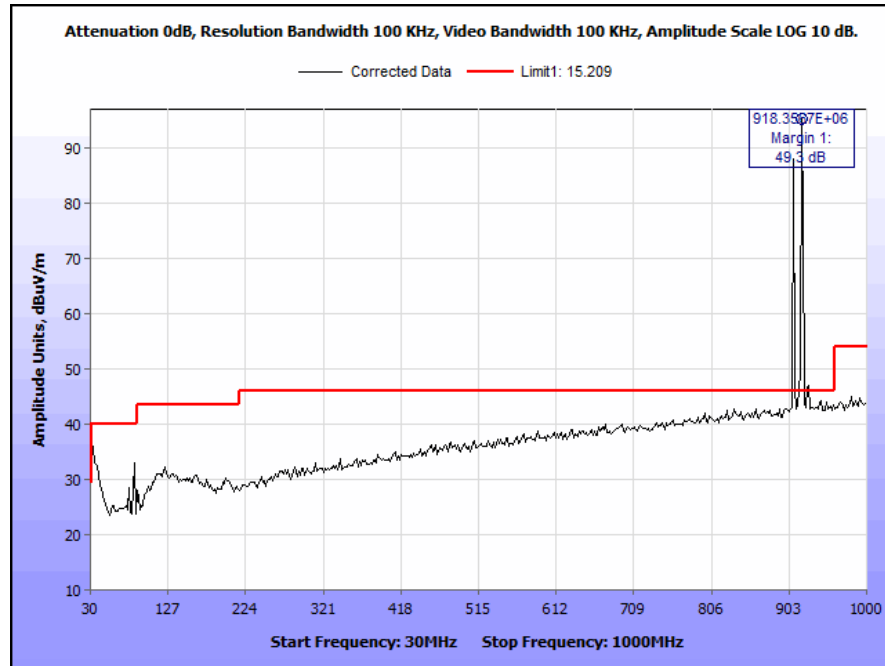
Note: The high emissions are the fundamentals of the two radios, and the spurs (with markers) are in-band.



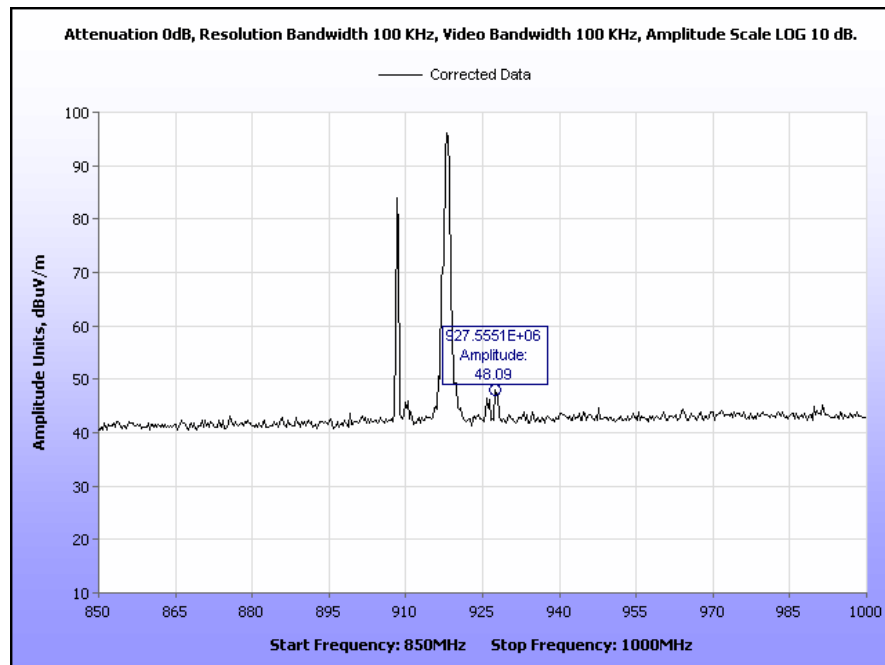
Plot 33. Transmitter Spurious Emissions, Low Channel, 1 GHz – 10 GHz, Peak under Average, Co-located with FCC ID: YL6-143200T5V4



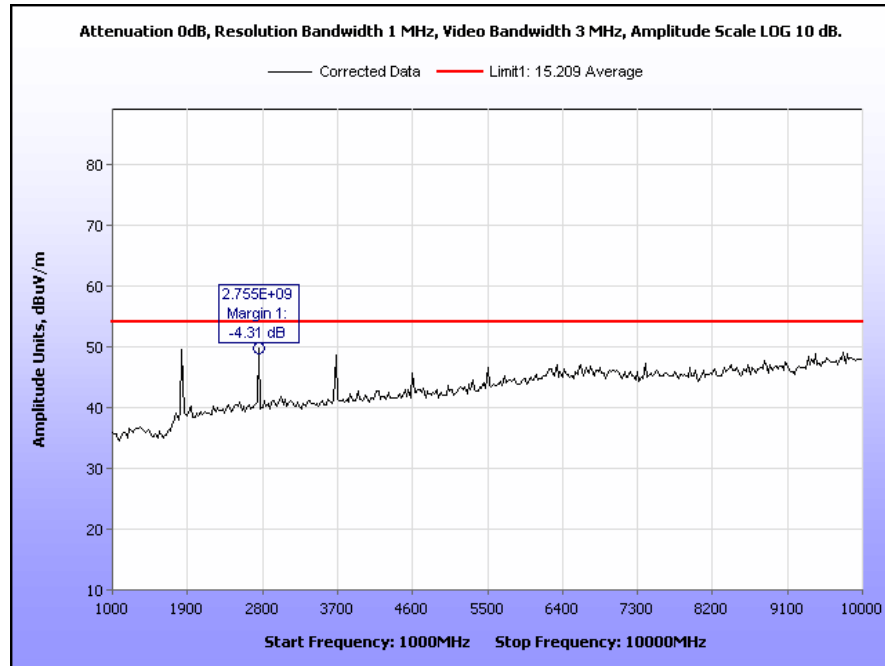
Plot 34. Transmitter Spurious Emissions, Low Channel, Co-located with FCC ID: YL6-143200T5V4



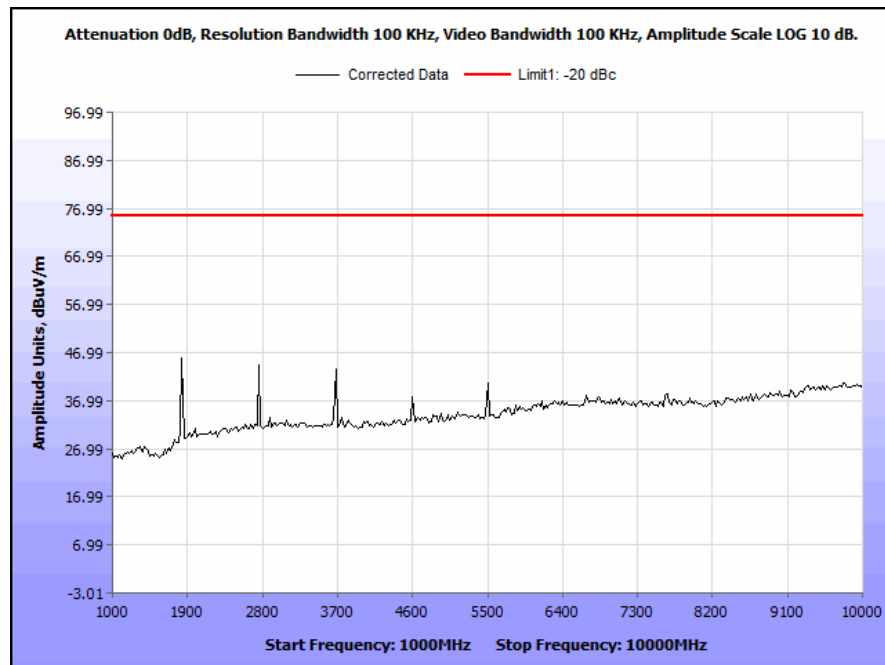
Plot 35. Radiated Spurious Emissions, Mid Channel, 30 MHz – 1 GHz, Co-located with FCC ID: YL6-143200T5V4



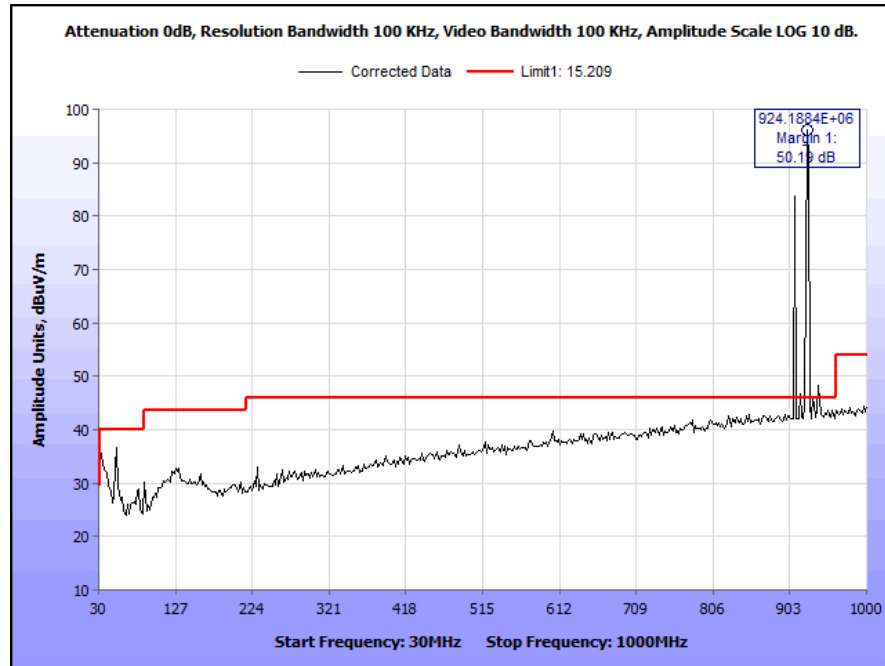
Plot 36. Transmitter Spurious Emissions, Mid Channel, Co-located with FCC ID: YL6-143200T5V4



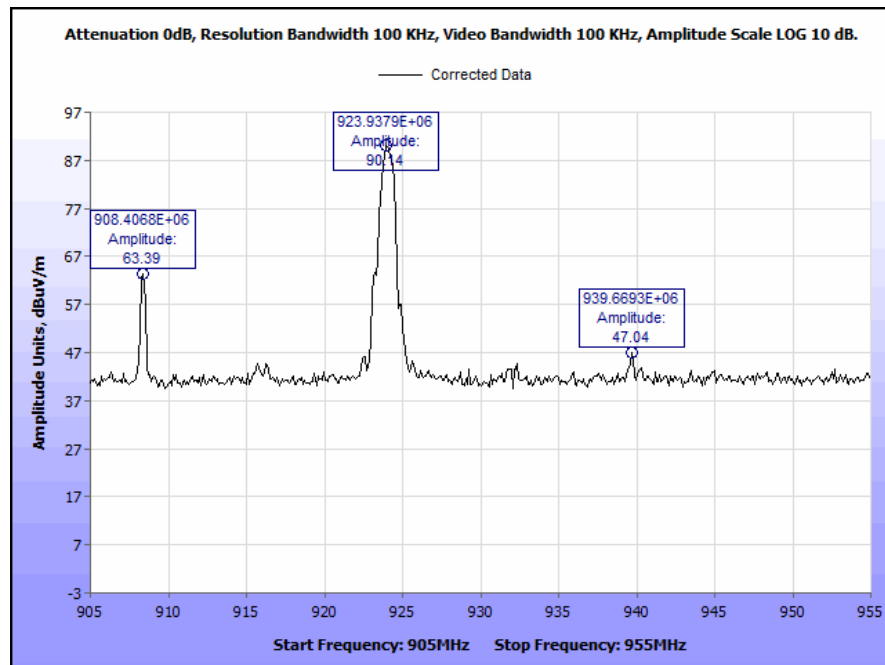
Plot 37. Transmitter Spurious Emissions, Mid Channel, 1 GHz – 10 GHz, Peak under Average, Co-located with FCC ID: YL6-143200T5V4



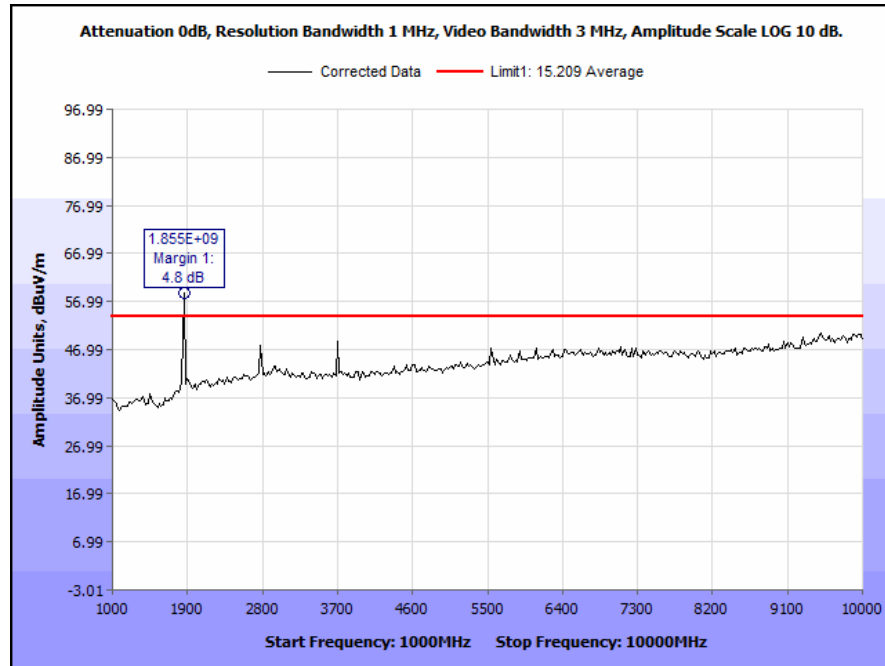
Plot 38. Transmitter Spurious Emissions, Mid Channel, Co-located with FCC ID: YL6-143200T5V4



Plot 39. Radiated Spurious Emissions, High Channel, 30 MHz – 1 GHz, Co-located with FCC ID: YL6-143200T5V4

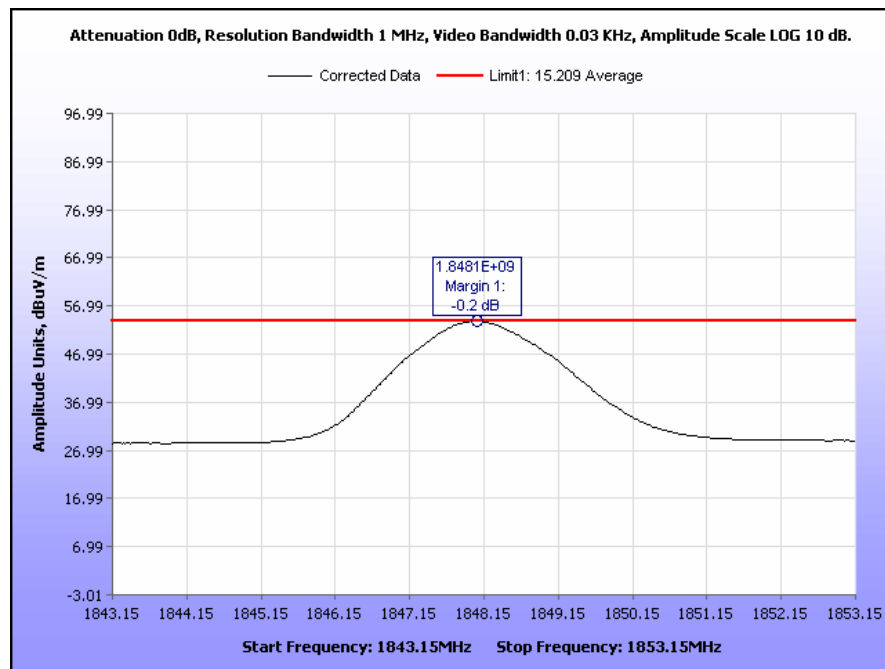


Plot 40. Transmitter Spurious Emissions, High Channel, 30 MHz – 1 GHz, Zoomed, Co-located with FCC ID: YL6-143200T5V4

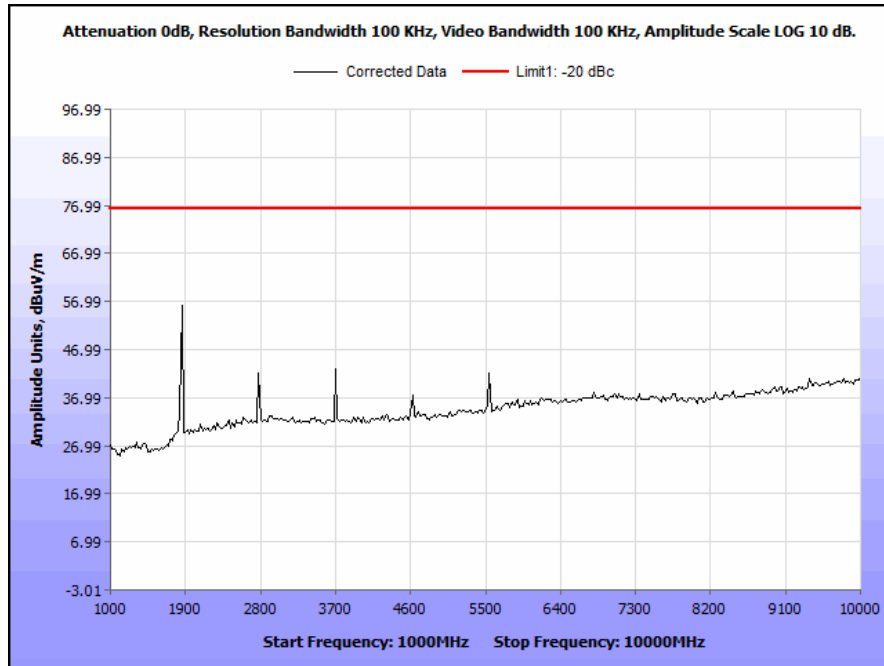


Plot 41. Transmitter Spurious Emissions, High Channel, 1 GHz – 10 GHz, Peak under Average

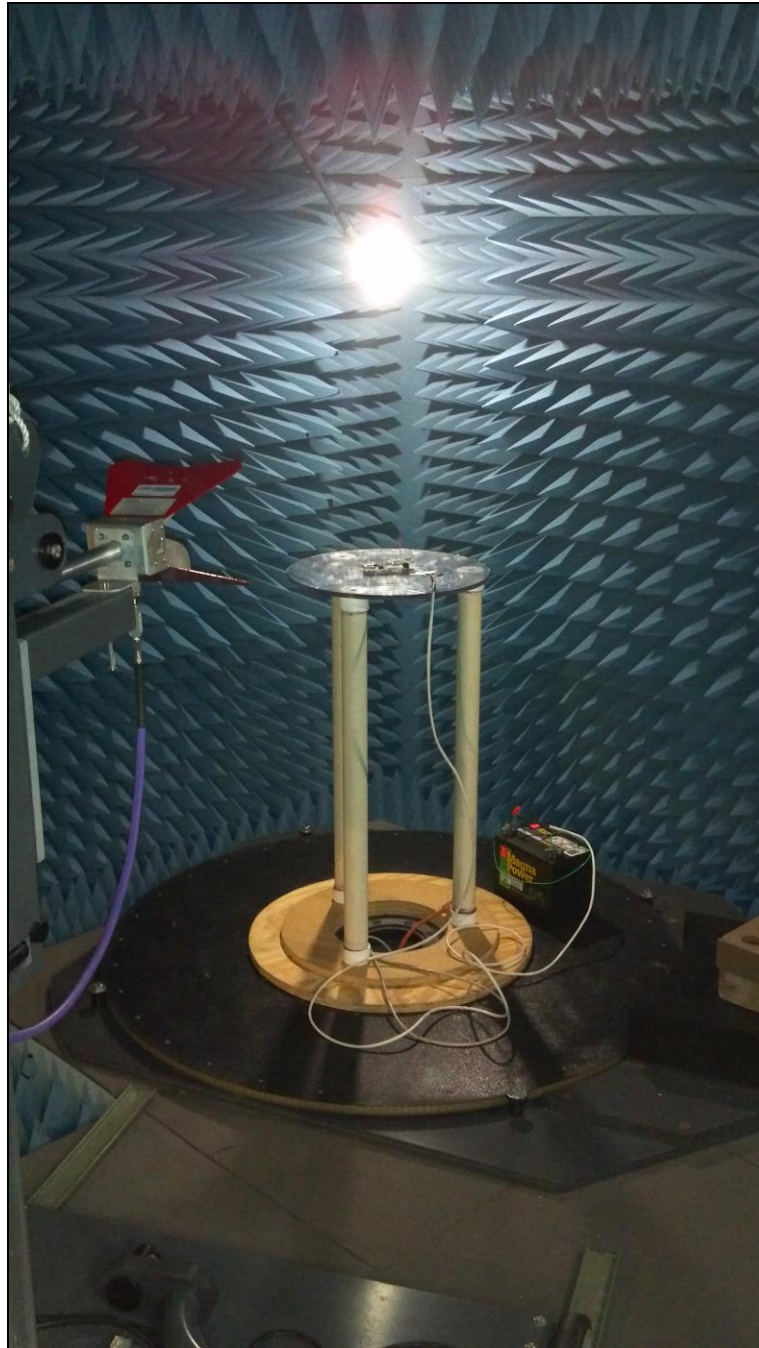
Note: with the exception of those denoted with markers; measured separately below, Co-located with FCC ID: YL6-143200T5V4



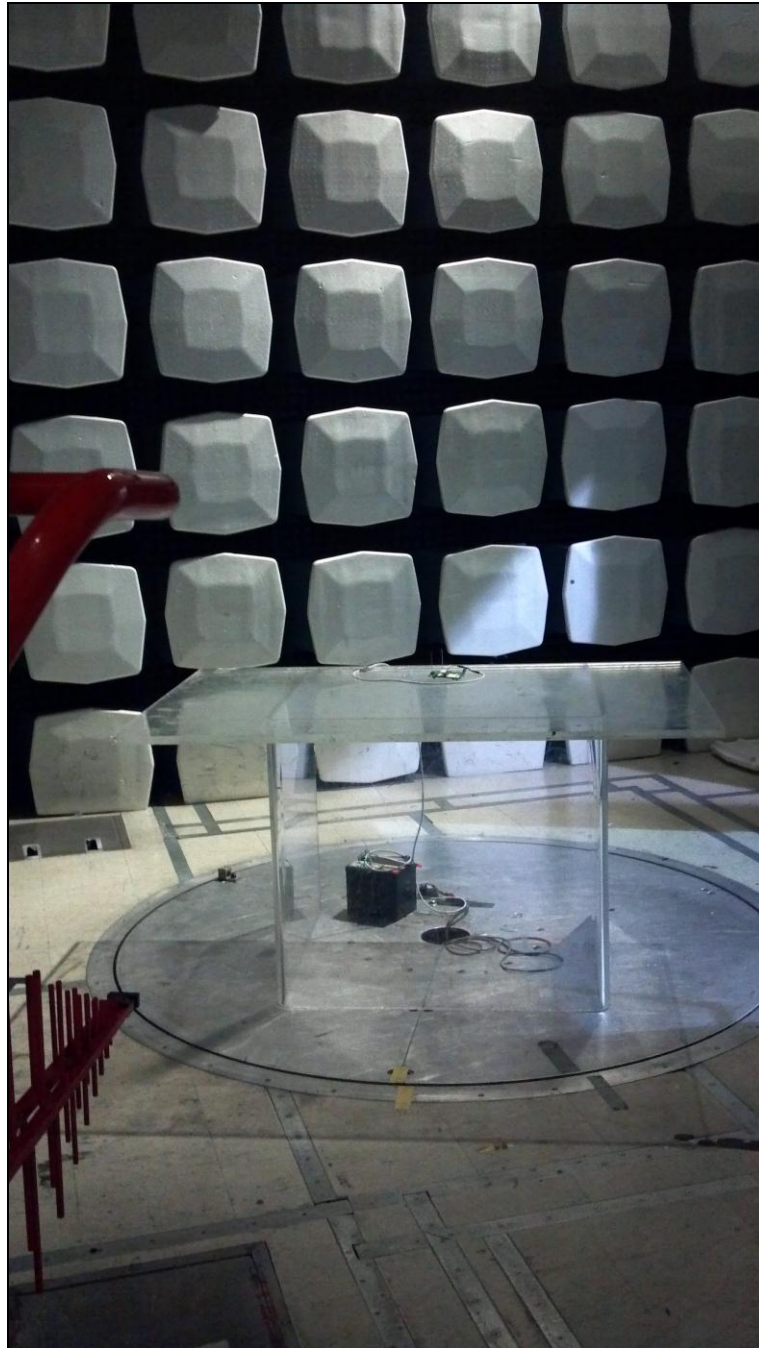
Plot 42. Transmitter Spurious Emissions, High Channel, Average, Co-located with FCC ID: YL6-143200T5V4



Plot 43. Transmitter Spurious Emissions, High Channel, Co-located with FCC ID: YL6-143200T5V4



Photograph 4. Collocation Test Setup, 1



Photograph 5. Collocation Test Setup, 2

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(i) Maximum Permissible Exposure

Test Purpose: Co-location of two modules, Z-wave module YL6-143200H5V4 and YL6-143IS205V4

RF Exposure Requirements: **§1.1307(b)(1) and §1.1307(b)(2):** Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

RF Radiation Exposure Limit: **§1.1310:** As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

MPE Calculation –

Co-Location of Z-wave module FCC ID: YL6-143200H5V4 and FCC ID: YL6-143IS205V4

Equation from page 18 of OET 65, Edition 97-01

$$S = \text{EIRP} / 4\pi R^2 \quad \text{or} \quad R = \sqrt{\text{PG} / 4\pi S}$$

YL6-143IS205V4:

MPE Limit Calculation: EUT's operating frequencies @ **912-924MHz**. Therefore, Limit for Uncontrolled exposure: 0.6 mW/cm²

EIRP = 16 mW

where, S = Power Density (mW/cm²)
EIRP = Equivalent Isotropic Radiated Power

$$S = (16 / 4 * 3.14 * 20.0^2) = 0.0032 \text{ mW/cm}^2 @ 20\text{cm separation}$$

YL6-143200H5V4:

MPE Limit Calculation: EUT's operating frequencies @ **908.4 MHz**. Therefore, Limit for Uncontrolled exposure: 0.6 mW/cm²

EUT field strength = 93.8495 dBuV/m @ 3m.
Using EIRP = E+20log(D) – 104.8,
Measured EIRP = 93.84+9.54-104.8 = -1.42 dBm = 0.72 mW

where, S = Power Density (mW/cm²)
EIRP = Equivalent Isotropic Radiated Power

$$S = (0.72 / 4 * 3.14 * 20.0^2) = 0.00014 \text{ mW/cm}^2 @ 20\text{cm separation}$$

MPE Calculation –

Co-Location of Z-wave module FCC ID: YL6-143200H5V4 and FCC ID: YL6-143IS205V4

MPE Summary:

Frequency Range	MPE Result (mW/cm ²)	Limit (mW/cm ²)
912-928 MHz	0.0032	0.6
908.4 MHz	0.00014	0.6

Test Requirements: [MPE1 + MPE2 < 0.6]

Test Results:

MPE(1) Frequency 902-928(MHZ)	MPE(2) Frequency 902-928(MHZ)	Calculation [MPE(1) + MPE(2) < 0.6]	MPE Result (mW/cm ²)	S as a fraction of the limit (%)
0.0032	0.00014	0.00334	0.00334	0.56

Therefore, the uncontrolled exposure limit is met at 20 cm when both transmitters are operating simultaneously.

Test Purpose: Co-location of two modules, Z-wave module YL6-143200C5V4 and YL6-143IS205V4

RF Exposure Requirements: **§1.1307(b)(1) and §1.1307(b)(2):** Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

RF Radiation Exposure Limit: **§1.1310:** As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

MPE Calculation –

Co-Location of Z-wave module FCC ID: YL6-143200C5V4 and FCC ID: YL6-143IS205V4

Equation from page 18 of OET 65, Edition 97-01

$$S = \text{EIRP} / 4\pi R^2 \quad \text{or} \quad R = \sqrt{\text{PG} / 4\pi S}$$

YL6-143IS205V4:

MPE Limit Calculation: EUT's operating frequencies @ **912-924MHz**. Therefore, Limit for Uncontrolled exposure: 0.6 mW/cm²

$$\text{EIRP} = 16 \text{ mW}$$

where, S = Power Density (mW/cm²)
EIRP = Equivalent Isotropic Radiated Power

$$S = (16 / 4 * 3.14 * 20.0^2) = 0.0032 \text{ mW/cm}^2 @ 20\text{cm separation}$$

YL6-143200C5V4:

MPE Limit Calculation: EUT's operating frequencies @ **908.4 MHz**. Therefore, Limit for Uncontrolled exposure: 0.6 mW/cm²

$$\text{EIRP} = 0.05 \text{ mW}$$

where, S = Power Density (mW/cm²)
EIRP = Equivalent Isotropic Radiated Power

$$S = (0.05 / 4 * 3.14 * 20.0^2) = 0.00001 \text{ mW/cm}^2 @ 20\text{cm separation}$$

MPE Calculation –

Co-Location of Z-wave module FCC ID: YL6-143200C5V4 and FCC ID: YL6-143IS205V4

MPE Summary:

Frequency Range	MPE Result (mW/cm ²)	Limit (mW/cm ²)
912-928 MHz	0.0032	0.6
908.4 MHz	0.00001	0.6

Test Requirements: [MPE1 + MPE2 < 0.6]

Test Results:

MPE(1) Frequency 902-928(MHZ)	MPE(2) Frequency 902-928(MHZ)	Calculation [MPE(1) + MPE(2) < 0.6]	MPE Result (mW/cm ²)	S as a fraction of the limit (%)
0.0032	0.00001	0.00321	0.00321	0.535

Therefore, the uncontrolled exposure limit is met at 20 cm when both transmitters are operating simultaneously.

Test Purpose: Co-location of two modules, Z-wave module YL6-143200T5V4 and YL6-143IS205V4

RF Exposure Requirements: **§1.1307(b)(1) and §1.1307(b)(2):** Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

RF Radiation Exposure Limit: **§1.1310:** As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

MPE Calculation –

Co-Location of Z-wave module FCC ID: YL6-143200T5V4 and FCC ID: YL6-143IS205V4

Equation from page 18 of OET 65, Edition 97-01

$$S = \text{EIRP} / 4\pi R^2 \quad \text{or} \quad R = \sqrt{\text{PG} / 4\pi S}$$

YL6-143IS205V4:

MPE Limit Calculation: EUT's operating frequencies @ **912-924MHz**. Therefore, Limit for Uncontrolled exposure: 0.6 mW/cm²

$$\text{EIRP} = 16 \text{ mW}$$

where, S = Power Density (mW/cm²)
EIRP = Equivalent Isotropic Radiated Power

$$S = (16 / 4 * 3.14 * 20.0^2) = 0.0032 \text{ mW/cm}^2 @ 20\text{cm separation}$$

YL6-143200T5V4:

MPE Limit Calculation: EUT's operating frequencies @ **908.4 MHz**. Therefore, Limit for Uncontrolled exposure: 0.6 mW/cm²

EUT field strength = 93.95 dBuV/m @ 3m.
Using EIRP = E + 20log(D) - 104.8,
Measured EIRP = 93.95 + 9.54 - 104.8 = -1.31 dBm = 0.74 mW

where, S = Power Density (mW/cm²)
EIRP = Equivalent Isotropic Radiated Power

$$S = (0.74 / 4 * 3.14 * 20.0^2) = 0.00015 \text{ mW/cm}^2 @ 20\text{cm separation}$$

MPE Calculation –

Co-Location of Z-wave module FCC ID: YL6-143200T5V4 and FCC ID: YL6-143200C5V4IS

MPE Summary:

Frequency Range	MPE Result (mW/cm ²)	Limit (mW/cm ²)
912-928 MHz	0.0032	0.6
908.4 MHz	0.00015	0.6

Test Requirements: [MPE1 + MPE2 < 0.6]

Test Results:

MPE(1) Frequency 902-928(MHZ)	MPE(2) Frequency 902-928(MHZ)	Calculation [MPE(1) + MPE(2) < 0.6]	MPE Result (mW/cm ²)	S as a fraction of the limit (%)
0.0032	0.00015	0.00335	0.00335	0.56

Therefore, the uncontrolled exposure limit is met at 20 cm when both transmitters are operating simultaneously.

IV. Test Equipment

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2005.

MET Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1T4300C	SEMI-ANECHOIC CHAMBER # 1 (VCCI)	EMC TEST SYSTEMS	NONE	01/31/2010	01/31/2013
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	07/16/2012	07/16/2013
1T4751	ANTENNA - BILOG	SUNOL SCIENCES	JB6	12/07/2011	12/07/2012
1T4771	SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4446A	12/12/2011	12/12/2012
1T4757	ANTENNA; HORN	ETS-LINDGREN	3117	02/18/2012	08/18/2013
1T4442	PRE-AMPLIFIER, MICROWAVE	MITEQ	AFS42-01001800- 30-10P	SEE NOTE	
1T4149	HIGH-FREQUENCY ANECHOIC CHAMBER	RAY-PROOF	81	NOT REQUIRED	

Table 7. Test Equipment List

Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing.

V. Certification & User's Manual Information

Certification & User's Manual Information

A. Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

§ 2.801 Radio-frequency device defined.

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

- (a) The various types of radio communication transmitting devices described throughout this chapter.
- (b) *The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.*
- (c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.
- (d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

§ 2.803 Marketing of radio frequency devices prior to equipment authorization.

- (a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:
 - (1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or
 - (2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.
- (d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.

- (e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:
- (i) *Compliance testing*;
 - (ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;
 - (iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;
 - (iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or
 - (v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.
- (e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.
- (f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.

Certification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart J — Equipment Authorization Procedures:

§ 2.901 Basis and Purpose

- (a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.¹ *In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.*
- (b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, and the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant.

§ 2.907 Certification.

- (a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.
- (b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

¹ In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart B (of Part 15), which deals with unintentional radiators.

Certification & User's Manual Information

§ 2.948 Description of measurement facilities.

- (a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.
- (1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.
- (i) *If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.*
- (ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.
- (2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.

Certification & User's Manual Information

1. Label and User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart A — General:

§ 15.19 Labeling requirements.

(a) *In addition to the requirements in Part 2 of this chapter, a device subject to certification or verification shall be labeled as follows:*

- (1) Receivers associated with the operation of a licensed radio service, e.g., FM broadcast under Part 73 of this chapter, land mobile operation under Part 90, etc., shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

- (2) A stand-alone cable input selector switch, shall bear the following statement in a conspicuous location on the device:

This device is verified to comply with Part 15 of the FCC Rules for use with cable television service.

- (3) All other devices shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

- (4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.

- (5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

§ 15.21 Information to user.

The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Verification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart B — Unintentional Radiators:

§ 15.105 Information to the user.

- (a) For a Class A digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at own expense.

- (b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

ICES-003 Procedural & Labeling Requirements

From the Industry Canada Electromagnetic Compatibility Advisory Bulletin entitled, "Implementation and Interpretation of the Interference-Causing Equipment Standard for Digital Apparatus, ICES-003" (EMCAB-3, Issue 2, July 1995):

"At present, CISPR 22: 2002 and ICES technical requirements are essentially equivalent. Therefore, if you have CISPR 22: 2002 approval by meeting CISPR Publication 22, the only additional requirements are: to attach a note to the report of the test results for compliance, indicating that these results are deemed satisfactory evidence of compliance with ICES-003 of the Canadian Interference-Causing Equipment Regulations; to maintain these records on file for the requisite five year period; and to provide the device with a notice of compliance in accordance with ICES-003."

Procedural Requirements:

According to Industry Canada's Interference Causing Equipment Standard for Digital Apparatus ICES-003 Issue 4, February 2004:

- Section 6.1: A record of the measurements and results, showing the date that the measurements were completed, shall be retained by the manufacturer or importer for a period of at least five years from the date shown in the record and made available for examination on the request of the Minister.
- Section 6.2: A written notice indicating compliance must accompany each unit of digital apparatus to the end user. The notice shall be in the form of a label that is affixed to the apparatus. Where because of insufficient space or other constraints it is not feasible to affix a label to the apparatus, the notice may be in the form of a statement in the user's manual.

Labeling Requirements:

The suggested text for the notice, in English and in French, is provided below, from the Annex of ICES-003:

This Class [²] digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe [¹] est conforme à la norme NMB-003 du Canada.

² Insert either A or B but not both as appropriate for the equipment requirements.

End of Report