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Salt Lake City, UT 84119
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Test Report

Certification

Test Of:
C4-EC100EXT

FCC ID: R33EC100

Test Specifications:
FCC PART 15, Subpart C

Test Report Serial No: 194767-3.1

Applicant:
Control4
11734 S. Election Road, Suite 200
Draper, UT 84020

Dates of Test:
October 1, 3, 4 & 20, 2011 and February 1, 2012

Issue Date:
February 7, 2012

Accredited Testing Laboratory By:



NVLAP Lab Code 100272-0

CERTIFICATION OF ENGINEERING REPORT

This report has been prepared by Nemko-CCL, Inc. to document compliance of the device described below with the requirements of Federal Communications Commission (FCC) Part 15, Subpart C. This report may be reproduced in full, partial reproduction may only be made with the written consent of the laboratory. The results in this report apply only to the sample tested.

- Applicant: Control4
- Manufacturer: Control4
- Brand Name: Control4
- Model Number: C4-EC100EXT
- FCC ID Number: R33EC100

On this 7th day of February 2012, I, individually, and for Nemko-CCL, Inc., certify that the statements made in this engineering report are true, complete, and correct to the best of my knowledge, and are made in good faith.

Although NVLAP has recognized that the Nemko-CCL, Inc. EMC testing facilities are in good standing, this report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government.

Nemko-CCL, Inc.



Tested by: Norman P. Hansen
EMC Technician

TABLE OF CONTENTS

	PAGE
SECTION 1.0 CLIENT INFORMATION	4
SECTION 2.0 EQUIPMENT UNDER TEST (EUT).....	5
SECTION 3.0 TEST SPECIFICATION, METHODS & PROCEDURES	8
SECTION 4.0 OPERATION OF EUT DURING TESTING.....	14
SECTION 5.0 SUMMARY OF TEST RESULTS	15
SECTION 6.0 802.11b/g TRANSCEIVER – MEASUREMENTS AND RESULTS	16
SECTION 7.0 ZIGBEE #1 TRANSCEIVER – MEASUREMENTS AND RESULTS	46
SECTION 8.0 ZIGBEE #2 TRANSCEIVER – MEASUREMENTS AND RESULTS	59
APPENDIX 1 TEST PROCEDURES AND TEST EQUIPMENT.....	72
APPENDIX 2 PHOTOGRAPHS.....	80
APPENDIX 3 MANUFACTURER’S STATEMENT/ATTESTATION.....	93
APPENDIX 4 TRANSMITTER DUTY CYCLE CALCULATIONS.....	94

SECTION 1.0 CLIENT INFORMATION

1.1 Applicant:

Company Name: Control4
11734 S. Election Road, Suite 200
Draper, UT 84020

Contact Name: Roger Midgley
Title: Sr. Regulatory Compliance Engineer

1.2 Manufacturer:

Company Name: Control4
11734 S. Election Road, Suite 200
Draper, UT 84020

Contact Name: Roger Midgley
Title: Sr. Regulatory Compliance Engineer

SECTION 2.0 EQUIPMENT UNDER TEST (EUT)**2.1 Identification of EUT:**

Brand Name: Control4
Model Number: C4-EC100EXT
Serial Number: None

2.2 Description of EUT:

The C4-EC100EXT is a home energy interface device in a 5" x 3.5" x 2.5" plastic enclosure. The C4-EC100EXT provides a touch screen interface from the user to the smart meter on his home for energy usage related information. When the C4-EC100EXT is used with the C4-WT100 Thermostat, it allows for remote control of the thermostat. The C4-EC100EXT contains a WiFi transceiver and two Zigbee transceivers. The WiFi transceiver and one of the Zigbee transceivers use traces on the PCB as antennas. . The second Zigbee transceiver has an external antenna connected to the PCB via a coaxial cable and mounts on the back of the C4-EC100EXT. The C4-EC100EXT was tested using 2 power supplies that supply power to the USB port of the C4-EC100EXT. The power supplies used in testing were the FranMar DSC-6PFA-05 and the Sparkle FSP010-DWDA1. 3 AA batteries supply power in the event of a power outage.

The C4-EC100EXT 802.11b/g transceiver uses 11 channels in the 2400 to 2483.5 MHz frequency range. The antenna is a trace on the PCB. See the table below.

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2412	5	2432	9	2452
2	2417	6	2437	10	2457
3	2422	7	2442	11	2462
4	2427	8	2447		

Testing was performed at the upper, middle, and lower channels using both 802.11b and 802.11g and data rates of 5.5, 11, and 48 mbps were used for the test results shown in this report.

The antenna for Zigbee Radio #1 is a trace on the PCB. Two antennas may be used for the Zigbee Radio #2. The first is a Pulse W1049B050, 2.0 dBi ¼ wave dipole and the second is a Socaa FI-03-01.13*21.6CM-M, a 2.5 dBi, ¼ wave dipole. Testing was performed with the Socaa antenna.

The C4-EC100EXT Zigbee transceivers use 15 channels in the 2400 to 2483.5 MHz frequency range. See the table of frequencies below.

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
11	2405	15	2425	19	2445	23	2465
12	2410	16	2430	20	2450	24	2470
13	2415	17	2435	21	2455	25	2475
14	2420	18	2440	22	2460		

The transmitter power settings that are incorporated in production software and were used in testing are shown below.

Radio	Channels	Transmit Power Setting	Amplifier Setting
Zigbee #1	11 – 25	+3	10
Zigbee #2	11 – 25	-3	20
802.11b	1 – 11	+12	N/A
802.11g	1 - 11	+15	N/A

This report covers the circuitry of the devices subject to FCC Part 15, Subpart C. The circuitry of the device subject to FCC Subpart B was found to be compliant and is covered in Nemko-CCL, Inc. report #194767-2.1

2.3 EUT and Support Equipment:

The FCC ID numbers for all the EUT and support equipment used during the test are listed below:

Brand Name Model Number Serial Number	FCC ID Number or Compliance	Description	Name of Interface Ports / Interface Cables
BN: Control4 MN: C4-EC100EXT SN: None	R33EC100	Home Energy Interface	See Section 2.4

2.4 Interface Ports on EUT:

There are no interface ports on the EUT. All communication is via the 802.11b/g or Zigbee

transceivers.

2.5 Modification Incorporated/Special Accessories on EUT:

There were no modifications or special accessories required to comply with the specification. This report is not complete without an accompanying signed attestation, included as Appendix 3, that the product will have all of the documented modifications incorporated into the product when manufactured and placed on the market.

SECTION 3.0 TEST SPECIFICATION, METHODS & PROCEDURES

3.1 Test Specification:

Title: FCC PART 15, Subpart C (47 CFR 15)
15.203, 15.207, and 15.247

Limits and methods of measurement of radio interference
characteristics of radio frequency devices.

Purpose of Test: The tests were performed to demonstrate initial compliance.

3.2 Methods & Procedures:

3.2.1 §15.203 Antenna Requirement

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

3.2.2 §15.207 Conducted Limits

(a) Except for Class A digital devices, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the band edges.

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

*Decreases with the logarithm of the frequency.

3.2.3 §15.247 Operation within the bands 902 – 928 MHz, 2400 – 2483.5 MHz, and 5725 – 5850 MHz

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

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400 – 2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudorandomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

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

(ii) Frequency hopping systems operating in the 5725-5850 MHz band shall use at least 75 hopping frequencies. The maximum 20 dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 non-overlapping channels. The average time of occupancy on any

channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 non-overlapping channels are used.

(2) Systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

(b) The maximum peak output power of the intentional radiator shall not exceed the following:

(1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

(2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

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

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

(c) Operation with directional antenna gains greater than 6 dBi.

(1) Fixed point-to-point operation:

(i) Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

(ii) Systems operating in the 5725-5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

(iii) Fixed, point-to-point operation, as used in paragraphs (b)(4)(i) and (b)(4)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum or digitally modulated intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

(2) In addition to the provisions in paragraphs (b)(1), (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400-2483.5 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:

(i) Different information must be transmitted to each receiver.

(ii) If the transmitter employs an antenna system that emits multiple directional beams but does not emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, i.e., the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna /antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:

(A) The directional gain shall be calculated as the sum of $10 \log$ (number of array elements or staves) plus the directional gain of the element or staff having the highest gain.

(B) A lower value for the directional gain than that calculated in paragraph (c)(2)(ii)(A) of this section will be accepted if sufficient

evidence is presented, e.g., due to shading of the array or coherence loss in the beamforming.

(iii) If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the power limit specified in paragraph (c)(2)(ii) of this section. If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the limit specified in paragraph (c)(2)(ii) of this section. In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the limit specified in paragraph (c)(2)(ii) of this section by more than 8 dB.

(iv) Transmitters that emit a single directional beam shall operate under the provisions of paragraph (c)(1) of this section.

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

(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

(f) For the purposes of this section, hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques. The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4. The digital modulation operation of the hybrid system, with the frequency hopping turned off, shall comply with the power density requirements of paragraph (d) of this section.

(g) Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

(h) The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

(i) 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. See § 1.1307(b)(1) of this Chapter.

Note: Spread spectrum systems are sharing these bands on a noninterference basis with systems supporting critical Government requirements that have been allocated the usage of these bands, secondary only to ISM equipment operated under the provisions of Part 18 of this Chapter. Many of these Government systems are airborne radiolocation systems that emit a high EIRP which can cause interference to other users. Also, investigations of the effect of spread spectrum interference to U. S. Government operations in the 902-928 MHz band may require a future decrease in the power limits allowed for spread spectrum operation.

3.2.3 Test Procedure

The conducted disturbance at mains ports and radiated disturbance testing was performed according to the procedures in ANSI C63.4: 2004. Testing was performed at Nemko-CCL, Inc.'s Wanship open area test site #2, located at 29145 Old Lincoln Highway, Wanship, UT. This site has been fully described in a report submitted to the FCC, and was accepted in a letter dated March 11, 2009 (90504).

Nemko-CCL, Inc. is accredited by National Voluntary Laboratory Accreditation Program (NVLAP); NVLAP Lab Code: 100272-0, which is effective until September 30, 2012.

For radiated emissions testing at 30 MHz or above that is performed at distances closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

SECTION 4.0 OPERATION OF EUT DURING TESTING

4.1 Operating Environment:

Power Supply: 120 VAC/ 60 Hz

4.2 Operating Modes:

The 802.11b/g transmitter was tested while in a constant transmit mode at the upper, middle, and lower channels. Both 802.11b and 802.11g modes were tested. Data rates were at 5.5 mb for spurious emissions and at 11 mb for all other testing in 802.11b mode. The data rate was at 48 mb for all 802.11g testing. Both Zigbee transceivers were tested at the upper, middle, and lower channels. The Zigbee #2 transceiver was tested with antenna vertical, horizontal away from the housing, and horizontal behind the housing. The AC power was varied in accordance with FCC §15.31(e). No change was seen in transmitter characteristics.

4.3 EUT Exercise Software:

Control4 software was used to exercise the transmitters.

SECTION 5.0 SUMMARY OF TEST RESULTS**5.1 FCC Part 15, Subpart C**

The C4-EC100EXT 802.11b/g transceiver and both Zigbee transceivers were subjected to each of the tests shown in the summary table below.

5.1.1 Summary of Tests:

Section	Environmental Phenomena	Frequency Range (MHz)	Result
15.203	Antenna Requirements	Structural requirement	Complied
15.207	Conducted Disturbance at Mains Ports	0.15 to 30	Complied
15.247(a)	Bandwidth Requirement	2400 – 2483.5	Complied
15.247(b)	Peak Output Power	2400 – 2483.5	Complied
15.247(c)	Antenna Conducted Spurious Emissions	30 - 25000	Complied
15.247(c)	Radiated Spurious Emissions	30 - 25000	Complied
15.247(d)	Peak Power Spectral Density	2400 – 2483.5	Complied
15.247(e)	Reserved Paragraph	N/A	Not Applicable
15.247(f)	Hybrid System Requirements	2400 – 2483.5	Not Applicable
15.247(g)	Frequency Hopping Channel Usage	2400 – 2438.5	Not Applicable
15.247(h)	Frequency Hopping Intelligence	2400 – 2483.5	Not Applicable

5.2 Result

In the configuration tested, the 802.11b/g transceiver and the Zigbee transceivers complied with the requirements of the specification.

SECTION 6.0 802.11b/g TRANSCEIVER – MEASUREMENTS AND RESULTS**6.1 General Comments:**

This section contains the test results only. Details of the test methods used and a list of the test equipment used during the measurements can be found in Appendix 1 of this report.

6.2 Test Results:**6.2.1 §15.203 Antenna Requirements**

The EUT uses a trace antenna on the PCB and is not user replaceable.

RESULT

The EUT complied with the specification.

6.2.2 §15.207 Conducted Disturbance at the AC Mains Ports

Frequency (MHz)	AC Mains Lead	Detector	Measured Level (dBμV)	Limit (dBμV)	Margin (dB)
0.16	Hot Lead	Peak (Note 1)	42.7	55.7	-13.0
0.18	Hot Lead	Peak (Note 1)	39.3	54.3	-15.0
0.41	Hot Lead	Peak (Note 1)	34.5	47.6	-13.1
0.59	Hot Lead	Peak (Note 1)	33.1	46.0	-12.9
1.04	Hot Lead	Peak (Note 1)	30.8	46.0	-15.2
1.55	Hot Lead	Peak (Note 1)	31.4	46.0	-14.6
2.01	Hot Lead	Peak (Note 1)	31.3	46.0	-14.7
0.16	Neutral Lead	Peak (Note 1)	42.4	55.7	-13.3
0.18	Neutral Lead	Peak (Note 1)	38.4	54.3	-15.9
0.33	Neutral Lead	Peak (Note 1)	37.3	49.3	-12.0
0.39	Neutral Lead	Peak (Note 1)	39.5	48.1	-8.6
0.56	Neutral Lead	Peak (Note 1)	33.2	46.0	-12.8
0.77	Neutral Lead	Peak (Note 1)	32.5	46.0	-13.5

Frequency (MHz)	AC Mains Lead	Detector	Measured Level (dBμV)	Limit (dBμV)	Margin (dB)
0.98	Neutral Lead	Peak (Note 1)	32.9	46.0	-13.1
1.24	Neutral Lead	Peak (Note 1)	31.3	46.0	-14.7
Note 1: The reference detector used for the measurements was quasi-peak and average and the data was compared to the respective limits.					

RESULT

In the configuration tested, the EUT complied with the specification by 8.6 dB.

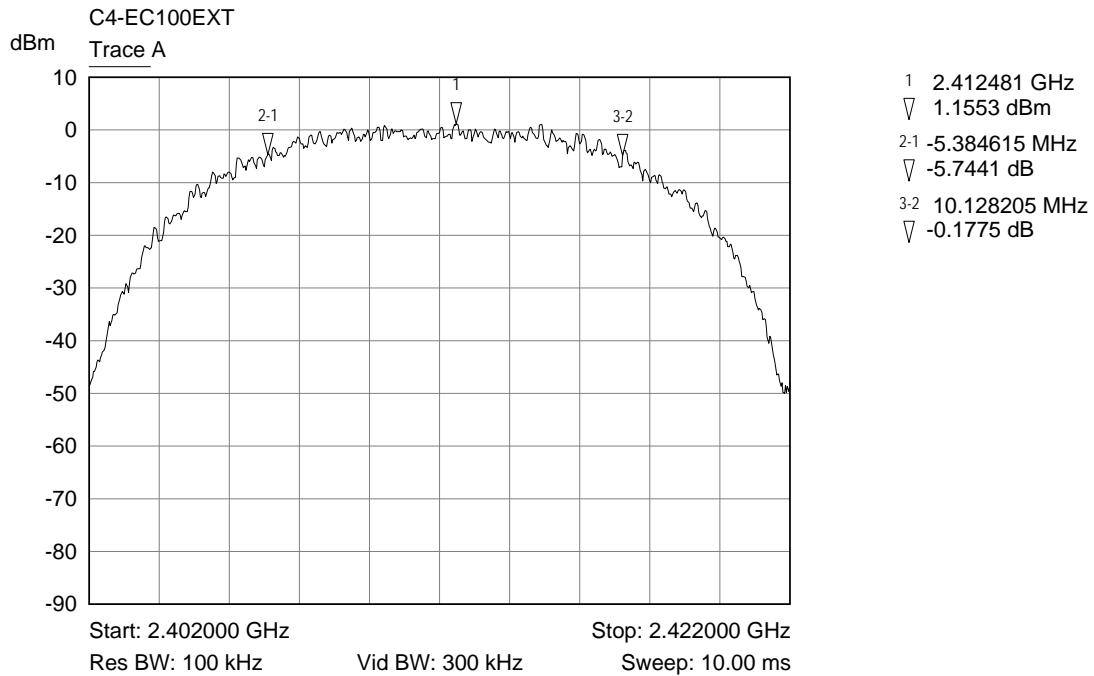
6.2.3 §15.247(a)(2) Emission Bandwidth

Frequency (MHz)	802.11b mode Emission 6 dB bandwidth (MHz)	802.11g mode Emission 6 dB bandwidth (MHz)
2412	10.13	16.57
2437	10.29	16.60
2462	10.29	16.54

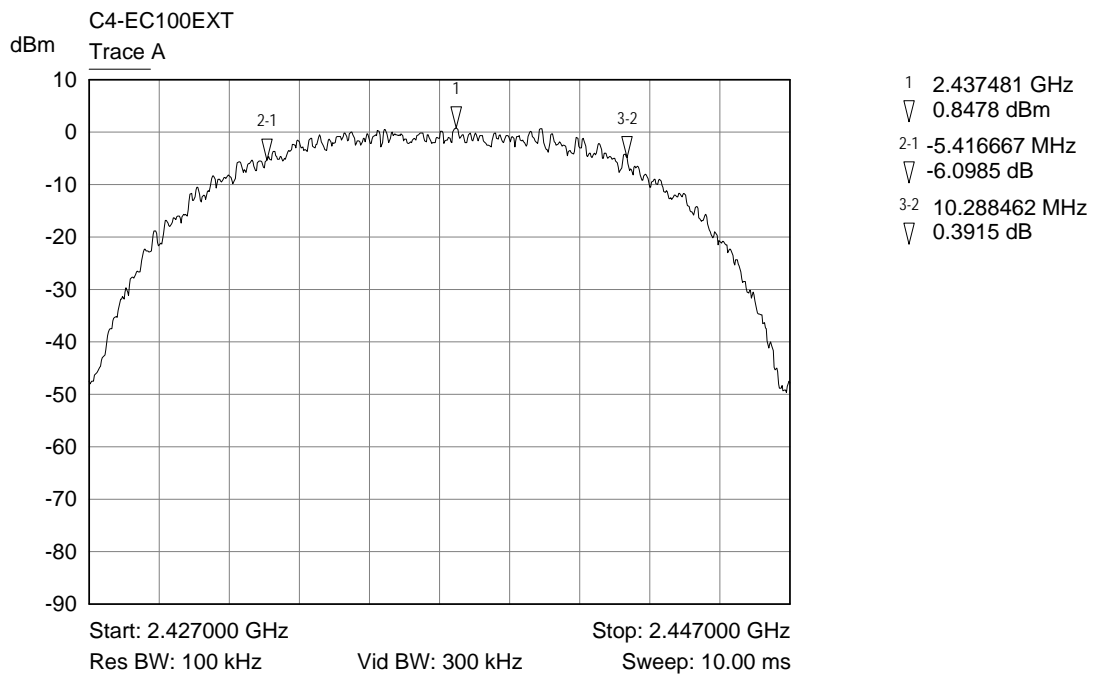
RESULT

In the configuration tested, the 6 dB bandwidth was greater than 500 kHz; therefore, the EUT complied with the requirements of the specification (see spectrum analyzer plots below).

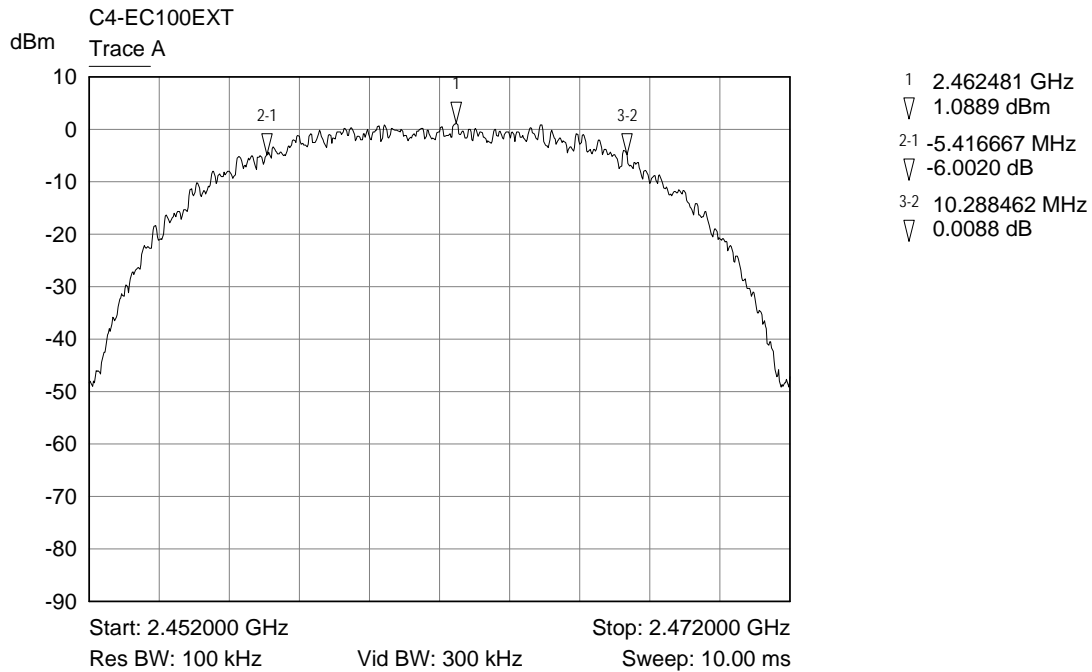
Lowest Channel 802.11b Emission 6 dB Bandwidth



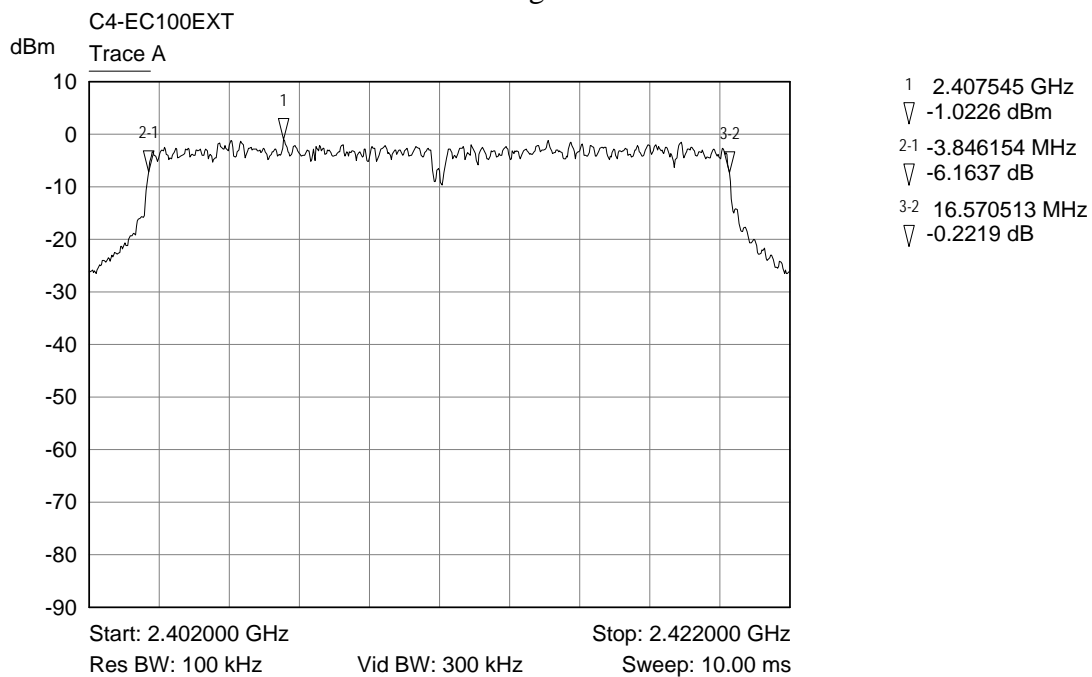
Middle Channel 802.11b Emission 6 dB Bandwidth



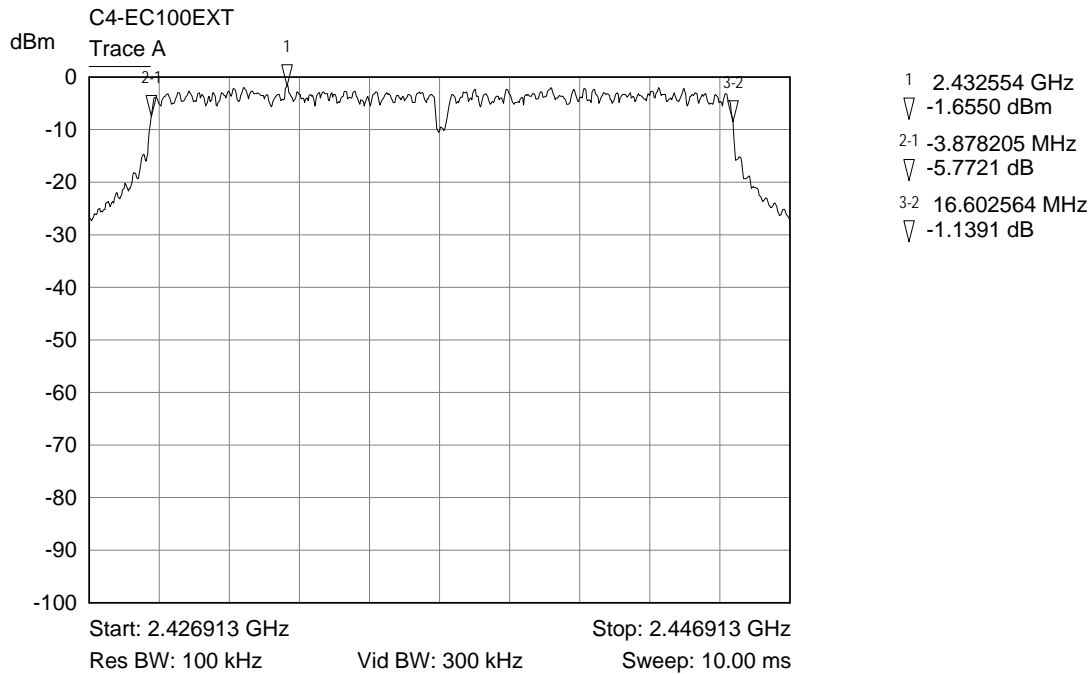
Highest Channel 802.11b Emission 6 dB Bandwidth



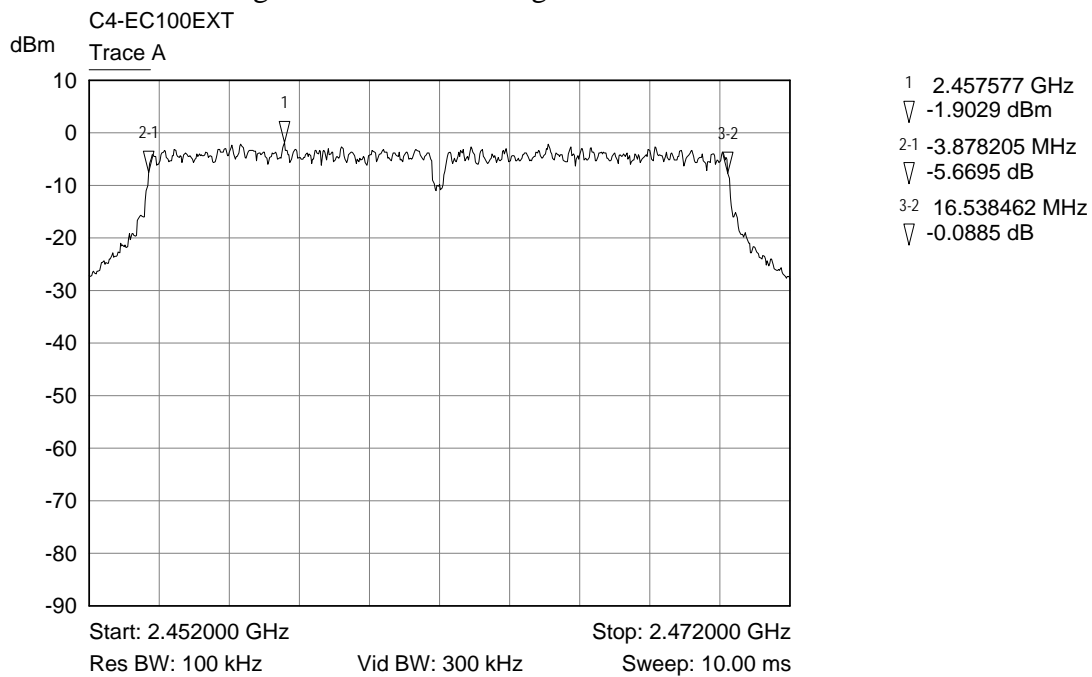
Lowest Channel 802.11g Emission 6 dB Bandwidth



Middle Channel 802.11g Emission 6 dB Bandwidth



Highest Channel 802.11g Emission 6 dB Bandwidth



6.2.4 §15.247(b)(3) Peak Output Power

The maximum peak RF Conducted output power measured for this device was 18.11 dBm or 64.71 mW. The limit is 30 dBm or 1 Watt when using antennas with 6 dBi or less gain. The 802.11b/g antenna has a gain of 0.33 dBi.

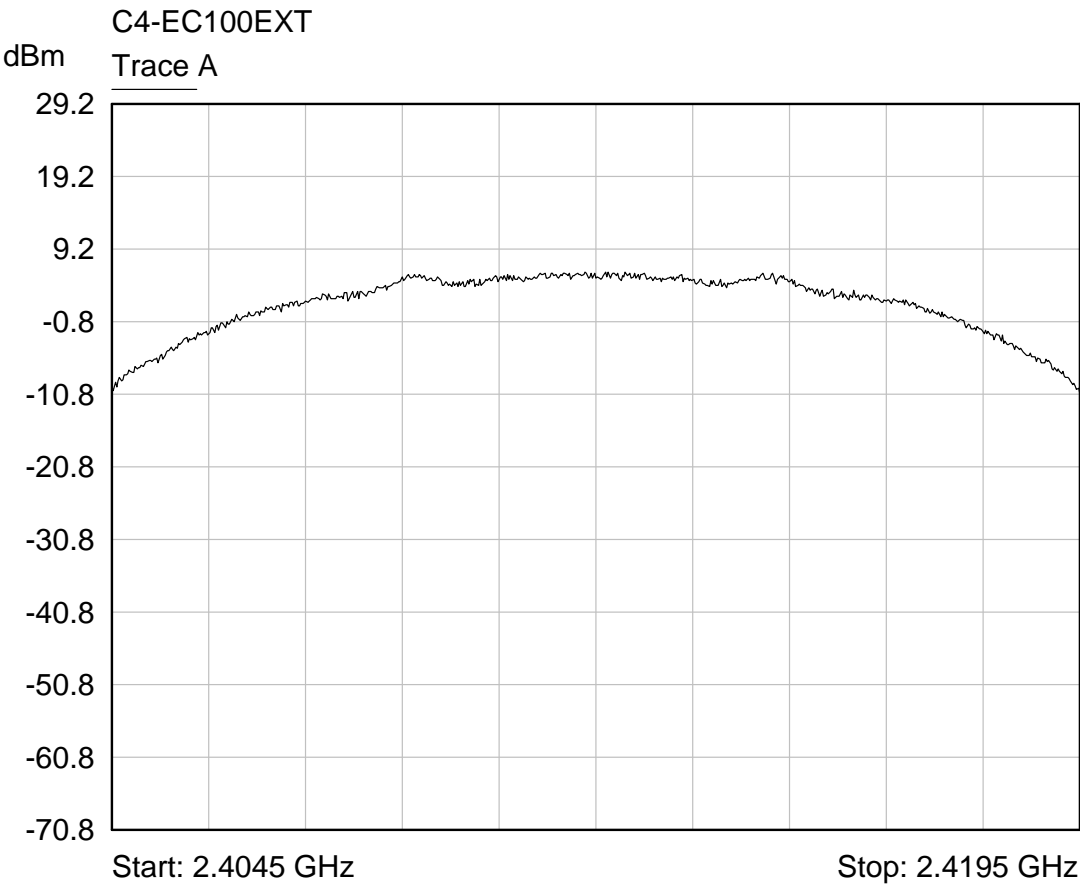
The maximum RBW of the spectrum analyzer was not larger than the bandwidth of the signal to be measured; therefore, the method described in Power Output Option 2, Method #1 of the FCC document, Measurement of Digital Transmission Systems Operating under Section 15.247, dated March 23, 2005, and KDB 558074 was used to measure the output power.

Frequency (MHz)	802.11b mode Measured Output Power (dBm)	802.11b mode Measured Output Power (mW)	802.11g mode Measured Output Power (dBm)	802.11g mode Measured Output Power (mW)
2412	14.12	25.82	18.11	64.71
2437	15.29	33.81	17.07	50.93
2462	15.56	35.97	15.79	37.93

RESULT

In the configuration tested, the RF peak output power was less than 1 Watt; therefore, the EUT complied with the requirements of the specification (see spectrum analyzer plots below).

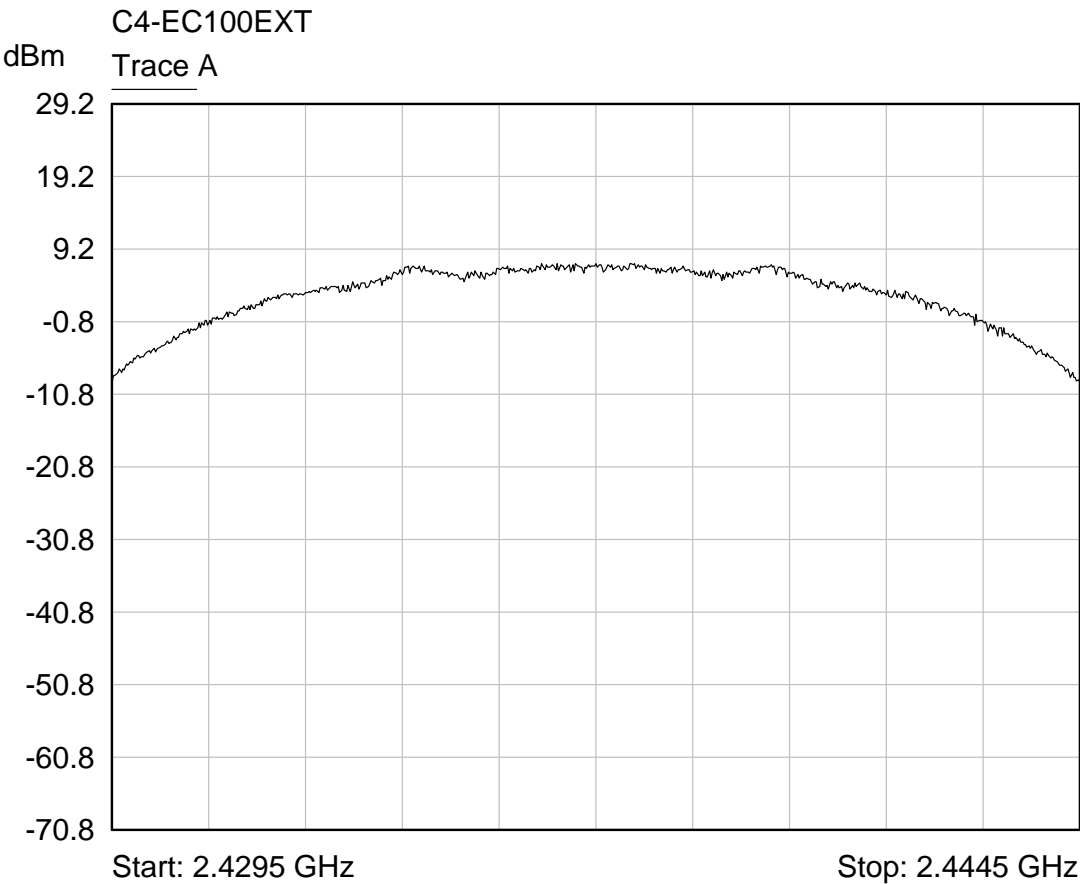
Lowest Channel 802.11b Output Power Plot



Trace A

Measurement Parameter	Value
Channel power	14.12 dBm

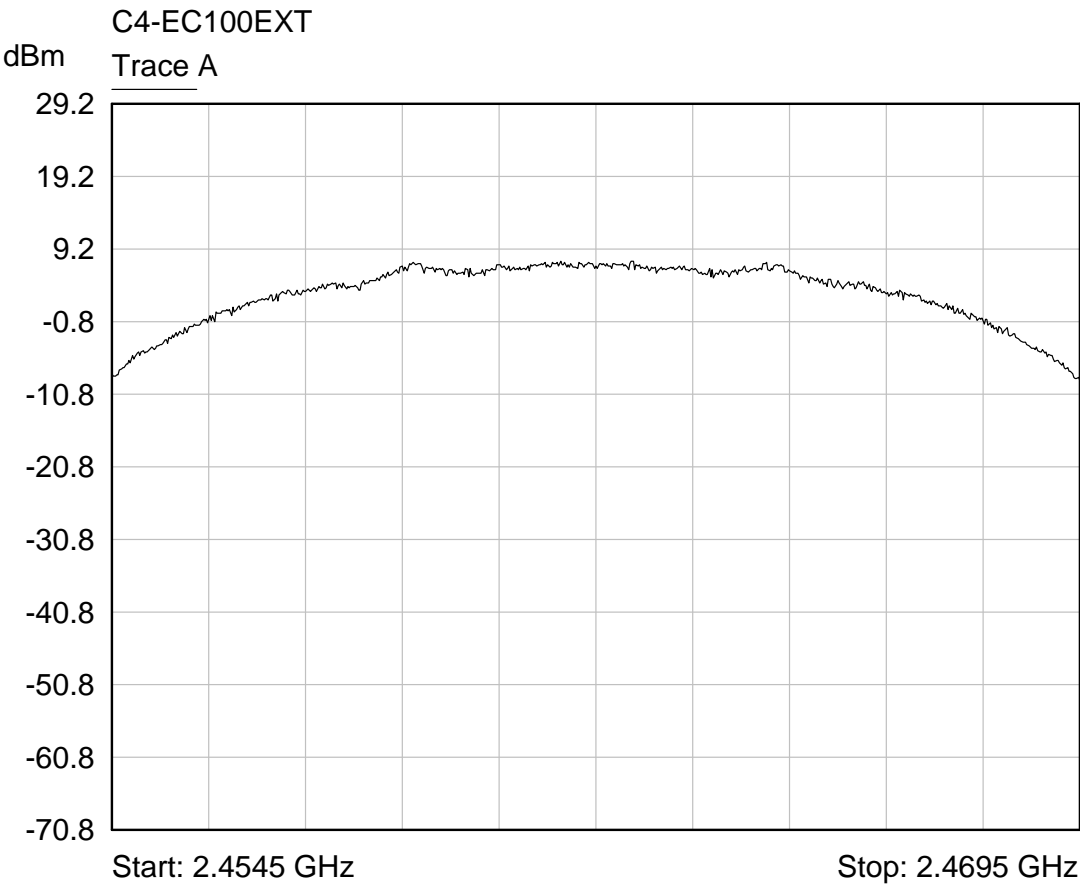
Middle Channel 802.11b Output Power Plot



Trace A

Measurement Parameter	Value
Channel power	15.29 dBm

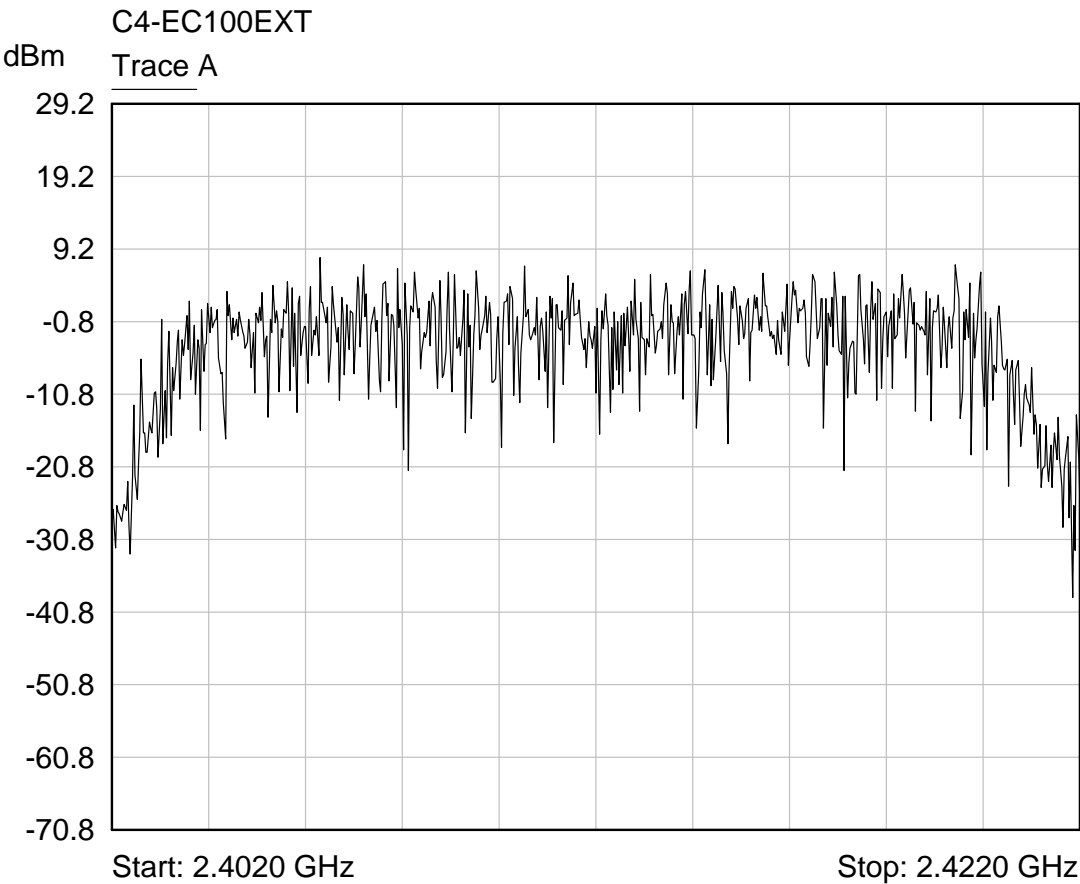
Highest Channel 802.11b Output Power Plot



Trace A

Measurement Parameter	Value
Channel power	15.56 dBm

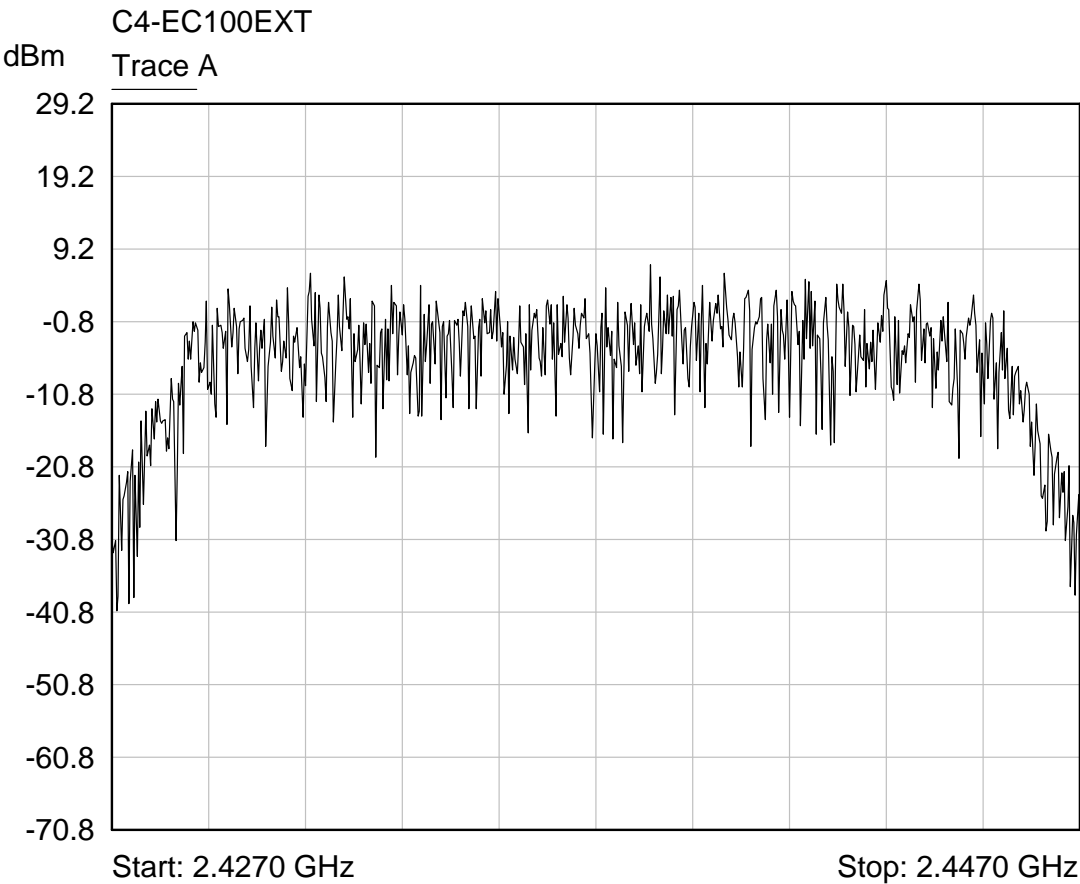
Lowest Channel 802.11g Output Power Plot



Trace A

Measurement Parameter	Value
Channel power	18.11 dBm

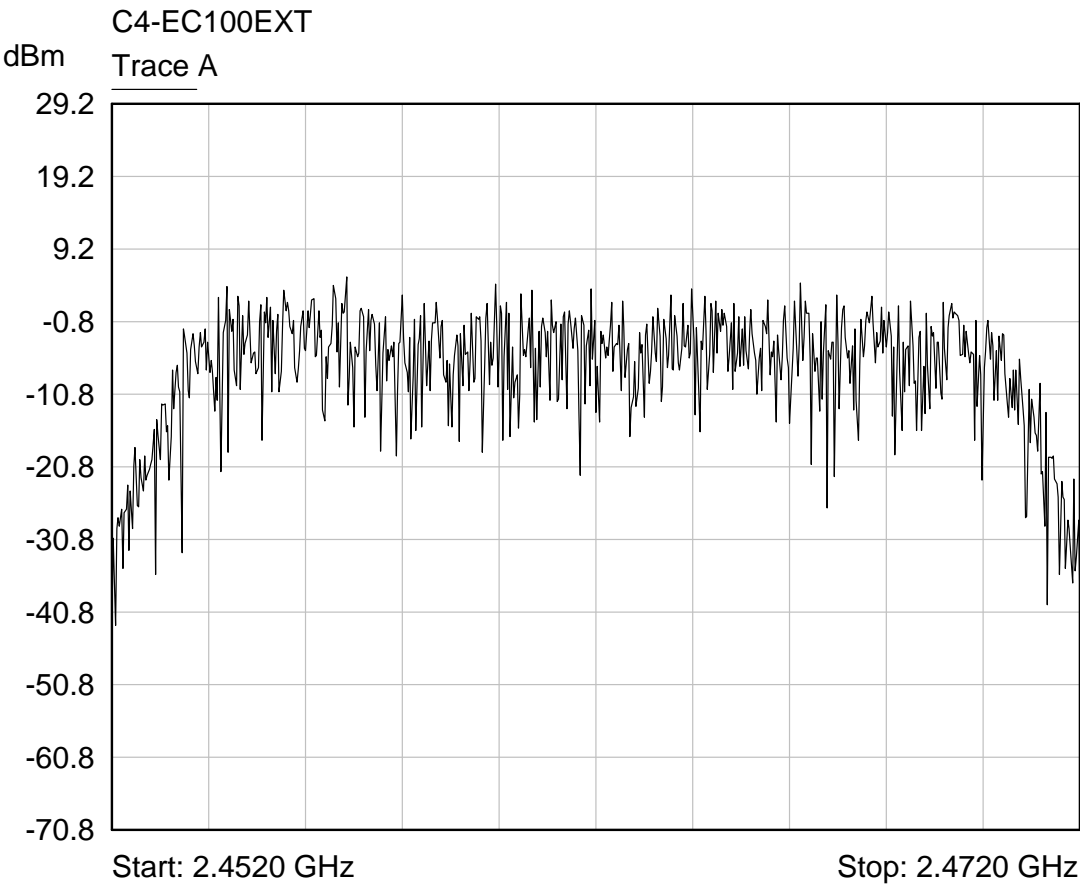
Middle Channel 802.11g Output Power Plot



Trace A

Measurement Parameter	Value
Channel power	17.07 dBm

Highest Channel 802.11g Output Power Plot



Trace A

Measurement Parameter	Value
Channel power	15.79 dBm

6.2.5 §15.247(c) Spurious Emissions**6.2.5.1 Conducted Spurious Emissions**

The frequency range from 8 MHz to the tenth harmonic of the highest fundamental frequency was investigated to measure any antenna-conducted emissions. The tables show the measurement data from spurious emissions noted across the frequency range when transmitting at the lowest frequency, middle frequency, and upper frequency. Shown below are plots with the EUT tuned to the upper and lower channels. These demonstrate compliance with the provisions of this section at the band edges.

The emissions must be attenuated 20 dB below the highest power level measured within the authorized band as measured with a 100 kHz RBW. The highest level measured in 802.11b mode was 1.1 dBm; therefore, the criteria is $1.1 - 20.0 = -18.9$ dBm. For 802.11g mode, the maximum level was -1.0 dBm; therefore, the criteria is $-1.0 - 20 = -21.0$ dBm.

RESULT

Conducted spurious emissions were attenuated 20 dB or more from the fundamental; therefore, the EUT complies with the specification.

6.2.5.1.1 802.11b Mode

Transmitting on the Lowest Channel (2412 MHz) 802.11b

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4824	-58.8	-18.9
7236	-74.9	-18.9
9648	-71.7	-18.9
12060	-76.3	-18.9
14472	-75.4	-18.9
16884	-75.6	-18.9
19296	-75.3	-18.9
21708	-75.3	-18.9
24120	-73.3	-18.9

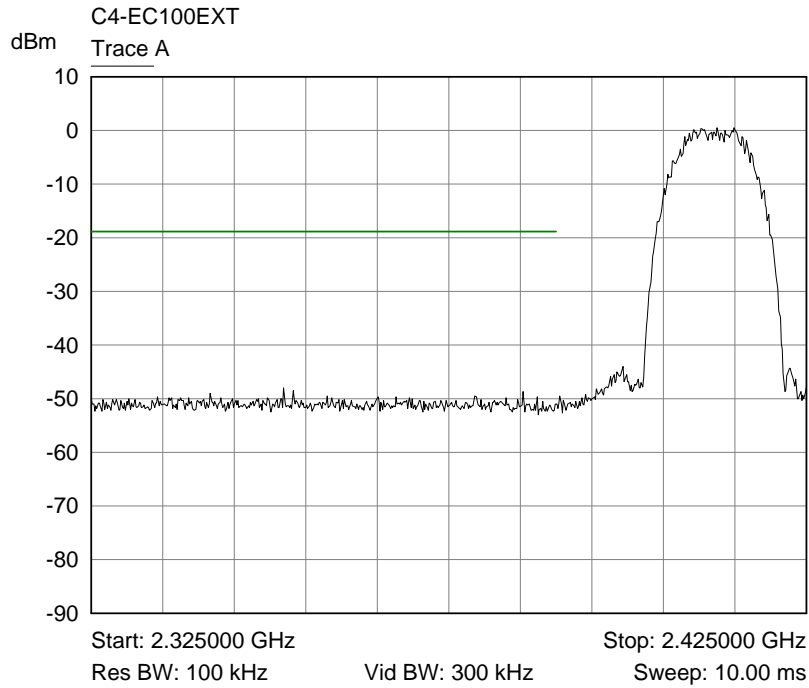
Transmitting on the Middle Channel (2437 MHz) 802.11b

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4874	-62.2	-18.9
7311	-76.2	-18.9
9748	-68.5	-18.9
12185	-76.5	-18.9
14662	-76.3	-18.9
17059	-76.0	-18.9
19496	-76.1	-18.9
21993	-75.5	-18.9
24370	-73.5	-18.9

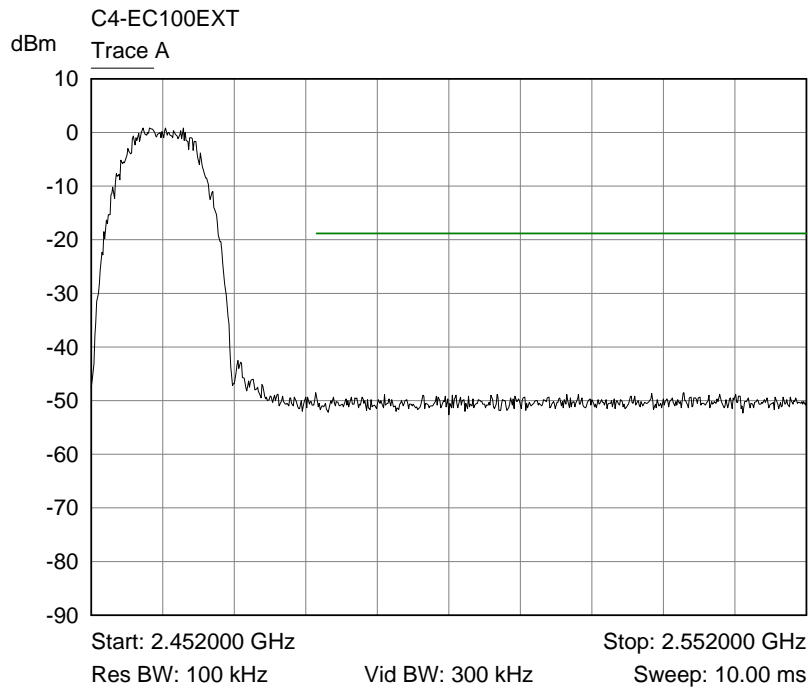
Transmitting on the Highest Channel (2462 MHz) 802.11b

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4924	-54.6	-18.9
7386	-76.0	-18.9
9848	-70.3	-18.9
12310	-76.7	-18.9
14772	-75.5	-18.9
17234	-75.2	-18.9
19696	-74.5	-18.9
22158	-75.3	-18.9
24620	-73.6	-18.9

Lower Band Edge Plot – 802.11b



Upper Band Edge Plot – 802.11b



6.2.5.1.2 802.11g Mode

Transmitting on the Lowest Channel (2412 MHz) 802.11g

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4824	-61.8	-21.0
7236	-75.7	-21.0
9648	-69.7	-21.0
12060	-76.6	-21.0
14472	-77.0	-21.0
16884	-76.3	-21.0
19296	-76.0	-21.0
21708	-76.1	-21.0
24120	-73.9	-21.0

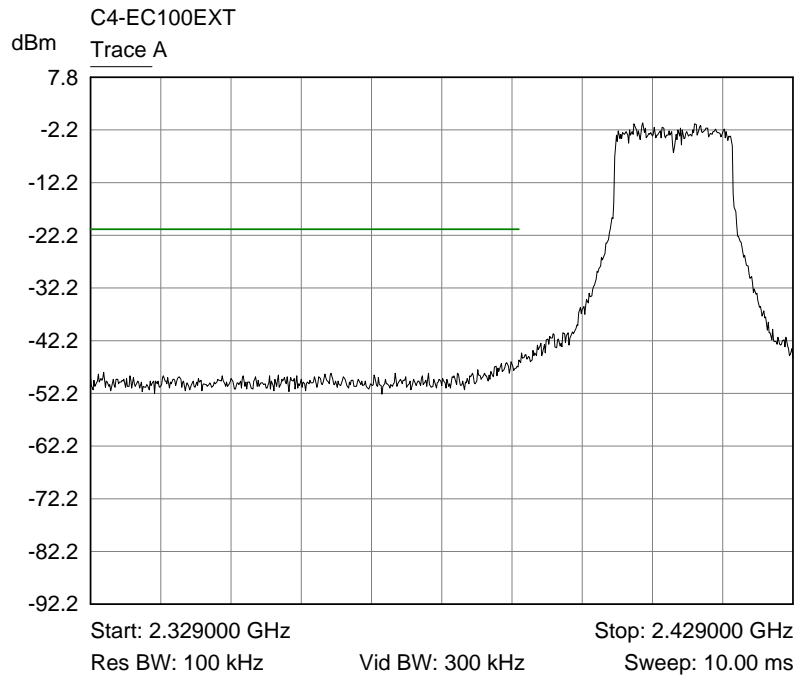
Transmitting on the Middle Channel (2437 MHz) 802.11g

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4874	-63.6	-21.0
7311	-72.2	-21.0
9748	-68.1	-21.0
12185	-75.2	-21.0
14662	-73.8	-21.0
17059	-73.2	-21.0
19496	-73.0	-21.0
21993	-74.0	-21.0
24370	-71.8	-21.0

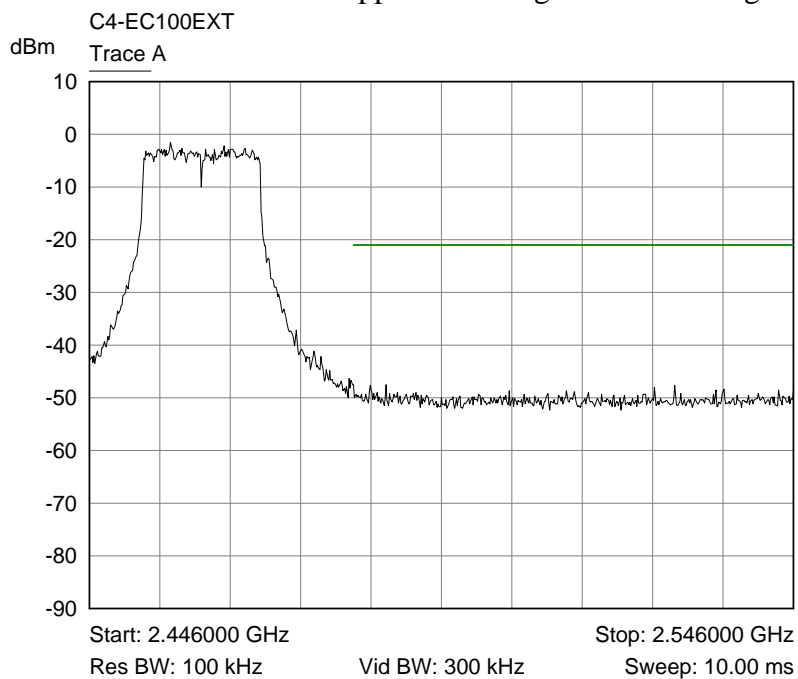
Transmitting on the Highest Channel (2462 MHz) 802.11g

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4924	-57.7	-21.0
7386	-76.7	-21.0
9848	-72.1	-21.0
12310	-76.5	-21.0
14772	-76.1	-21.0
17234	-75.5	-21.0
19696	-73.5	-21.0
22158	-75.1	-21.0
24620	-73.3	-21.0

Lower Band Edge Plot – 802.11g



Upper Band Edge Plot – 802.11g



6.2.5.2 Radiated Emissions in the Restricted Bands of §15.205

The frequency range from 30 MHz to 25 GHz was investigated to measure any radiated emissions in the restricted bands. The following tables show measurements of any emission that fell into the restricted bands of §15.205. The tables show the worst-case emission measured from the C4-EC100EXT. For frequencies above 12.5 GHz, a measurement distance of 1 meter was used. The noise floor was a minimum of 6 dB below the limit. The emissions in the restricted bands must meet the limits specified in §15.209. Tabular data for each of the spurious emissions is shown below for each of the units. Plots of the band edges are also shown.

For frequencies below 1000 MHz RBW = 100 kHz and VBW = 300 kHz, For frequencies above 1000 MHz RBW = 1 MHz and VBW = 3 MHz.

AVERAGE FACTOR

There was no average factor applied.

RESULT

All emissions in the restricted bands of §15.205 met the limits specified in §15.209; therefore, the EUT complies with the specification.

6.2.5.2.1 802.11b Mode

Transmitting at the Lowest Frequency (2412 MHz)

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4824.0	Peak	Vertical	16.9	37.6	54.5	74.0	-19.5
4824.0	Average	Vertical	9.8	37.6	47.4	54.0	-6.6
4824.0	Peak	Horizontal	19.7	37.6	57.3	74.0	-16.7
4824.0	Average	Horizontal	13.0	37.6	50.6	54.0	-3.4
7236.0	Peak	Vertical	2.5	41.4	43.9	74.0	-30.1
7236.0	Average	Vertical	-5.9	41.4	35.5	54.0	-18.5
7236.0	Peak	Horizontal	4.8	41.4	46.2	74.0	-27.8
7236.0	Average	Horizontal	-3.4	41.4	38.0	54.0	-16.0
12060.0	Peak	Vertical	-0.8	46.0	45.2	74.0	-28.8

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
12060.0	Average	Vertical	-10.4	46.0	35.6	54.0	-18.4
12060.0	Peak	Horizontal	0.9	46.0	46.9	74.0	-27.1
12060.0	Average	Horizontal	-9.9	46.0	36.1	54.0	-17.9

Transmitting at the Middle Frequency (2437 MHz)

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4874.0	Peak	Vertical	11.3	37.7	49.0	74.0	-25.0
4874.0	Average	Vertical	7.2	37.7	44.9	54.0	-9.1
4874.0	Peak	Horizontal	13.6	37.7	51.3	74.0	-22.7
4874.0	Average	Horizontal	9.3	37.7	47.0	54.0	-7.0
7311.0	Peak	Vertical	2.1	41.7	43.8	74.0	-30.2
7311.0	Average	Vertical	-8.3	41.7	33.4	54.0	-20.6
7311.0	Peak	Horizontal	2.6	41.7	44.3	74.0	-29.7
7311.0	Average	Horizontal	-7.5	41.7	34.2	54.0	-19.8
12185.0	Peak	Vertical	1.5	45.7	47.2	74.0	-26.8
12185.0	Average	Vertical	-10.0	45.7	35.7	54.0	-18.3
12185.0	Peak	Horizontal	0.9	45.7	46.6	74.0	-27.4
12185.0	Average	Horizontal	-10.0	45.7	35.7	54.0	-18.3

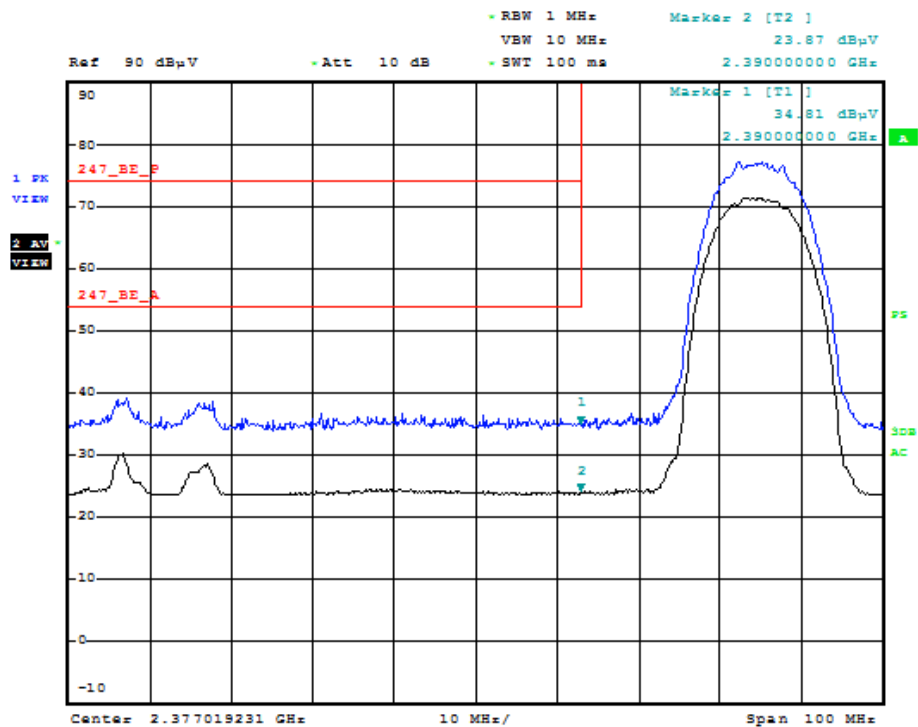
Transmitting at the Highest Frequency (2462 MHz)

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4924.0	Peak	Vertical	13.3	37.8	51.1	74.0	-22.9
4924.0	Average	Vertical	4.8	37.8	42.6	54.0	-11.4
4924.0	Peak	Horizontal	15.4	37.8	53.2	74.0	-20.8
4924.0	Average	Horizontal	10.2	37.8	48.0	54.0	-6.0

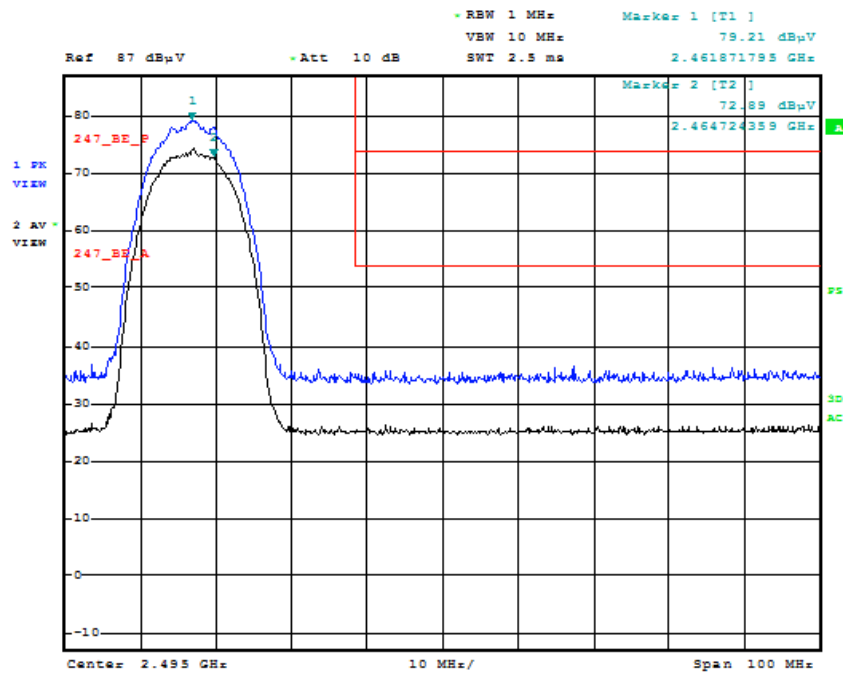
Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
7386.0	Peak	Vertical	4.3	41.8	46.1	74.0	-27.9
7386.0	Average	Vertical	-4.6	41.8	37.2	54.0	-16.8
7386.0	Peak	Horizontal	5.0	41.8	46.8	74.0	-27.2
7386.0	Average	Horizontal	-3.1	41.8	38.7	54.0	-15.3
12310.0	Peak	Vertical	1.9	45.5	47.4	74.0	-26.6
12310.0	Average	Vertical	-9.0	45.5	36.5	54.0	-17.5
12310.0	Peak	Horizontal	2.4	45.5	47.9	74.0	-26.1
12310.0	Average	Horizontal	-9.1	45.5	36.4	54.0	-17.6

No other emissions were seen in the restricted bands. Noise floor was greater than 6 dB below the limit. At frequencies above 12.5 GHz, a 1 meter measurement distance was used.

Radiated Lower Band Edge Plot



Radiated Upper Band Edge Plot

**6.2.5.2.2 802.11g Mode**

Transmitting at the Lowest Frequency (2412 MHz)

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4824.0	Peak	Vertical	16.6	37.6	54.2	74.0	-19.8
4824.0	Average	Vertical	7.2	37.6	44.8	54.0	-9.2
4824.0	Peak	Horizontal	19.7	37.6	57.3	74.0	-16.7
4824.0	Average	Horizontal	9.8	37.6	47.4	54.0	-6.6
7236.0	Peak	Vertical	7.8	41.4	49.2	74.0	-24.8
7236.0	Average	Vertical	-4.1	41.4	37.3	54.0	-16.7
7236.0	Peak	Horizontal	8.6	41.4	50.0	74.0	-24.0
7236.0	Average	Horizontal	-3.0	41.4	38.4	54.0	-15.6

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
12060.0	Peak	Vertical	-0.8	46.0	45.2	74.0	-28.8
12060.0	Average	Vertical	-10.4	46.0	35.6	54.0	-18.4
12060.0	Peak	Horizontal	0.9	46.0	46.9	74.0	-27.1
12060.0	Average	Horizontal	-9.9	46.0	36.1	54.0	-17.9

Transmitting at the Middle Frequency (2437 MHz)

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4874.0	Peak	Vertical	10.6	37.7	48.3	74.0	-25.7
4874.0	Average	Vertical	-0.2	37.7	37.5	54.0	-16.5
4874.0	Peak	Horizontal	15.0	37.7	52.7	74.0	-21.3
4874.0	Average	Horizontal	4.7	37.7	42.4	54.0	-11.6
7311.0	Peak	Vertical	3.8	41.7	45.5	74.0	-28.5
7311.0	Average	Vertical	-7.5	41.7	34.2	54.0	-19.8
7311.0	Peak	Horizontal	5.5	41.7	47.2	74.0	-26.8
7311.0	Average	Horizontal	-6.5	41.7	35.2	54.0	-18.8
12185.0	Peak	Vertical	1.5	45.7	47.2	74.0	-26.8
12185.0	Average	Vertical	-10.0	45.7	35.7	54.0	-18.3
12185.0	Peak	Horizontal	0.9	45.7	46.6	74.0	-27.4
12185.0	Average	Horizontal	-10.0	45.7	35.7	54.0	-18.3

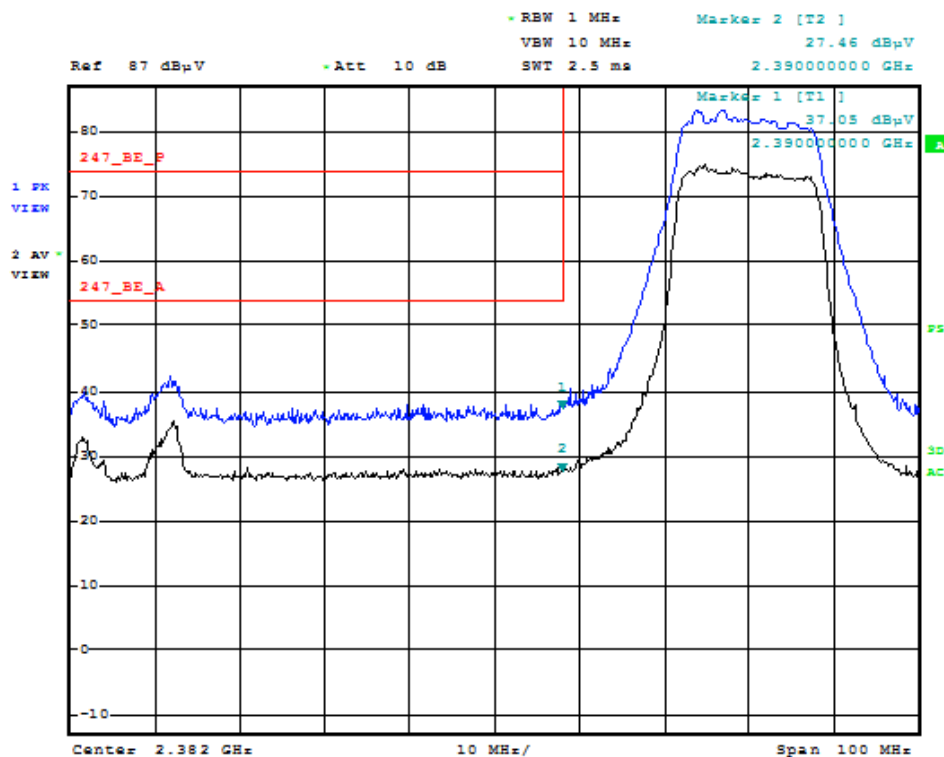
Transmitting at the Highest Frequency (2462 MHz)

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4924.0	Peak	Vertical	9.8	37.8	47.6	74.0	-26.4
4924.0	Average	Vertical	-1.1	37.8	36.7	54.0	-17.3
4924.0	Peak	Horizontal	17.7	37.8	55.5	74.0	-18.5
4924.0	Average	Horizontal	6.8	37.8	44.6	54.0	-9.4

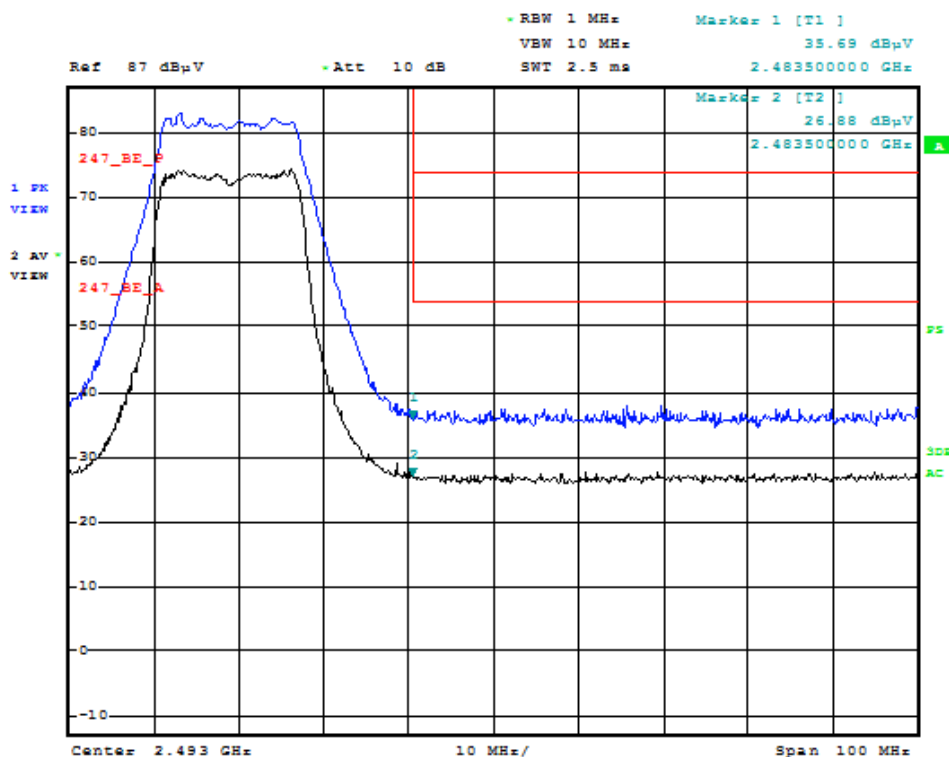
Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
7386.0	Peak	Vertical	6.4	41.8	48.2	74.0	-25.8
7386.0	Average	Vertical	-5.7	41.8	36.1	54.0	-17.9
7386.0	Peak	Horizontal	7.7	41.8	49.5	74.0	-24.5
7386.0	Average	Horizontal	-4.4	41.8	37.4	54.0	-16.6
12310.0	Peak	Vertical	1.9	45.5	47.4	74.0	-26.6
12310.0	Average	Vertical	-9.0	45.5	36.5	54.0	-17.5
12310.0	Peak	Horizontal	2.4	45.5	47.9	74.0	-26.1
12310.0	Average	Horizontal	-9.1	45.5	36.4	54.0	-17.6

No other emissions were seen in the restricted bands. Noise floor was greater than 6 dB below the limit. At frequencies above 12.5 GHz, a 1 meter measurement distance was used.

Radiated Lower Band Edge Plot



Radiated Upper Band Edge Plot

**6.2.6 §15.247(d) Peak Power Spectral Density**

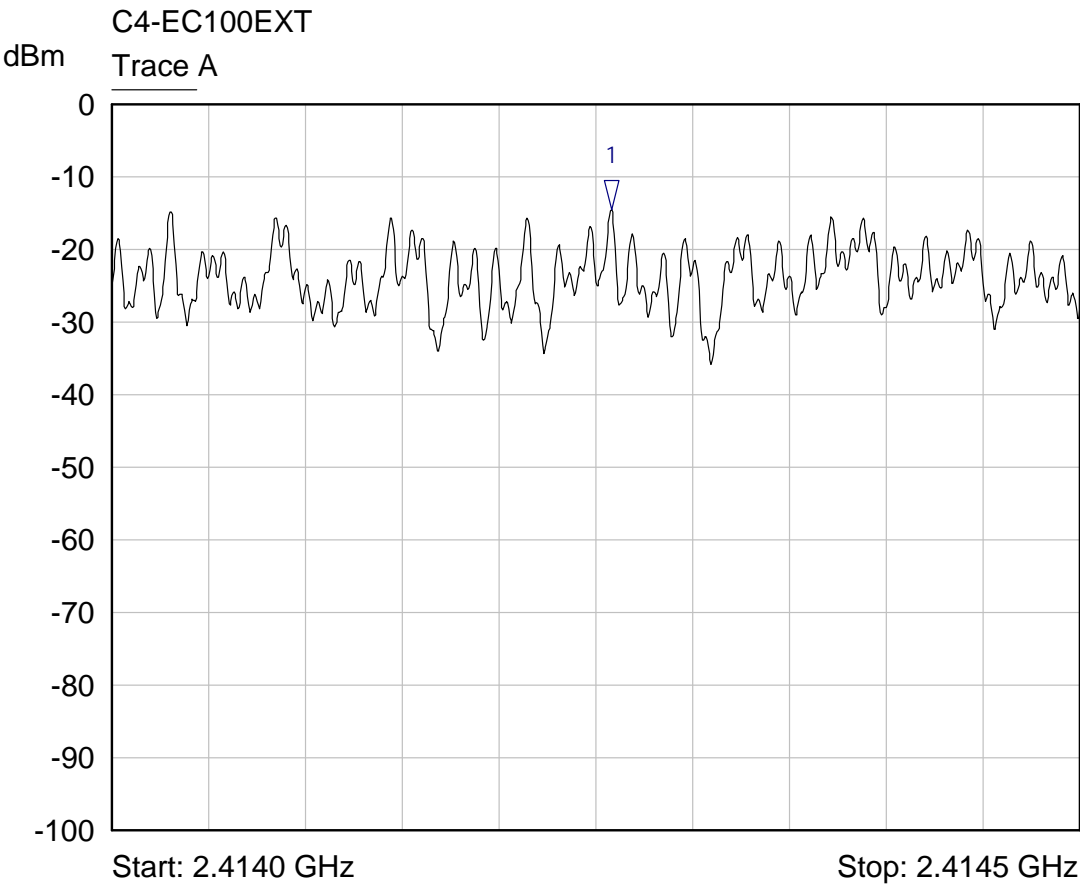
The peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. Since the method described in Power Output Option 2, Method #1 FCC document, Measurement of Digital Transmission Systems Operating under Section 15.247, dated March 23, 2005 was used to measure and sum the power, the method in PSD Option 2 of the FCC document was used to measure the 3 kHz power spectral density of the emission. The result of this testing is summarized in the table below.

Frequency (MHz)	802.11b Measurement (dBm)	802.11g Measurement (dBm)	Criteria (dBm)
2412	-14.55	-15.54	8.0
2437	-12.46	-13.67	8.0
2462	-10.00	-13.91	8.0

RESULT

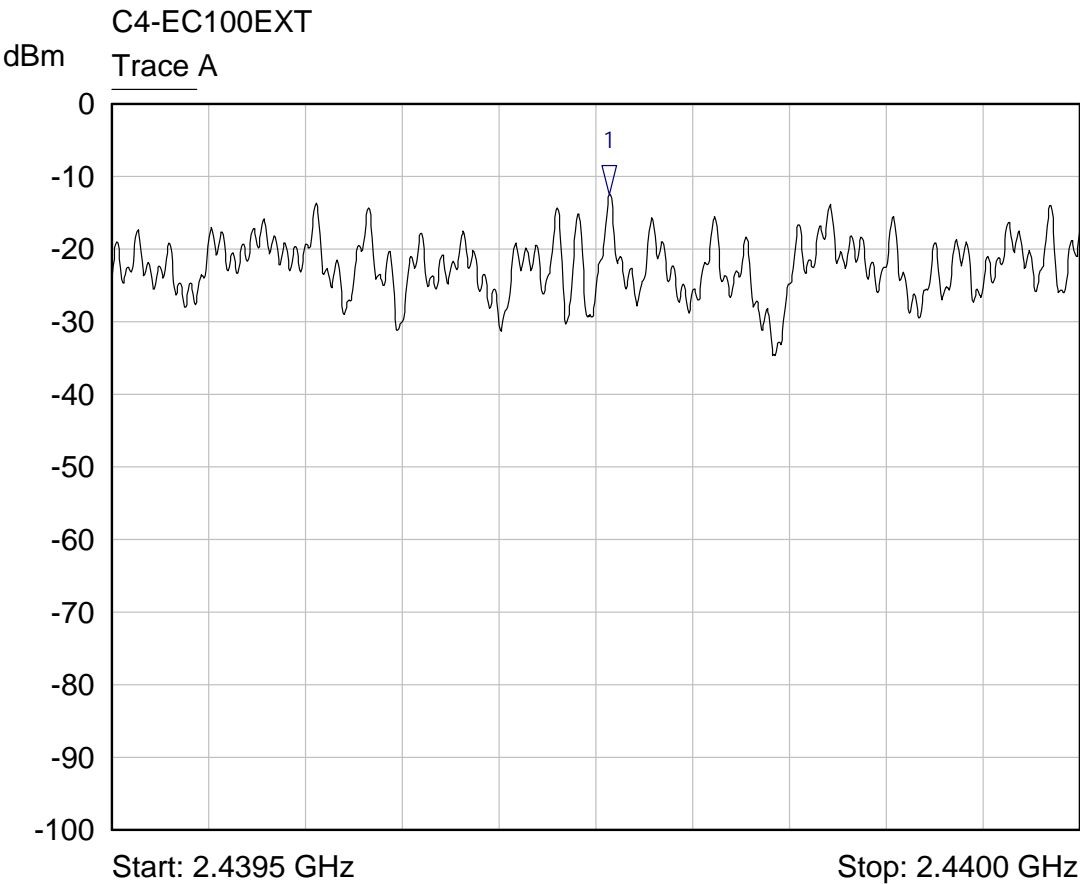
The maximum peak power spectral density was -10.0 dBm. The EUT complies with the specification by 18.0 dB.

Lowest channel – 802.11b



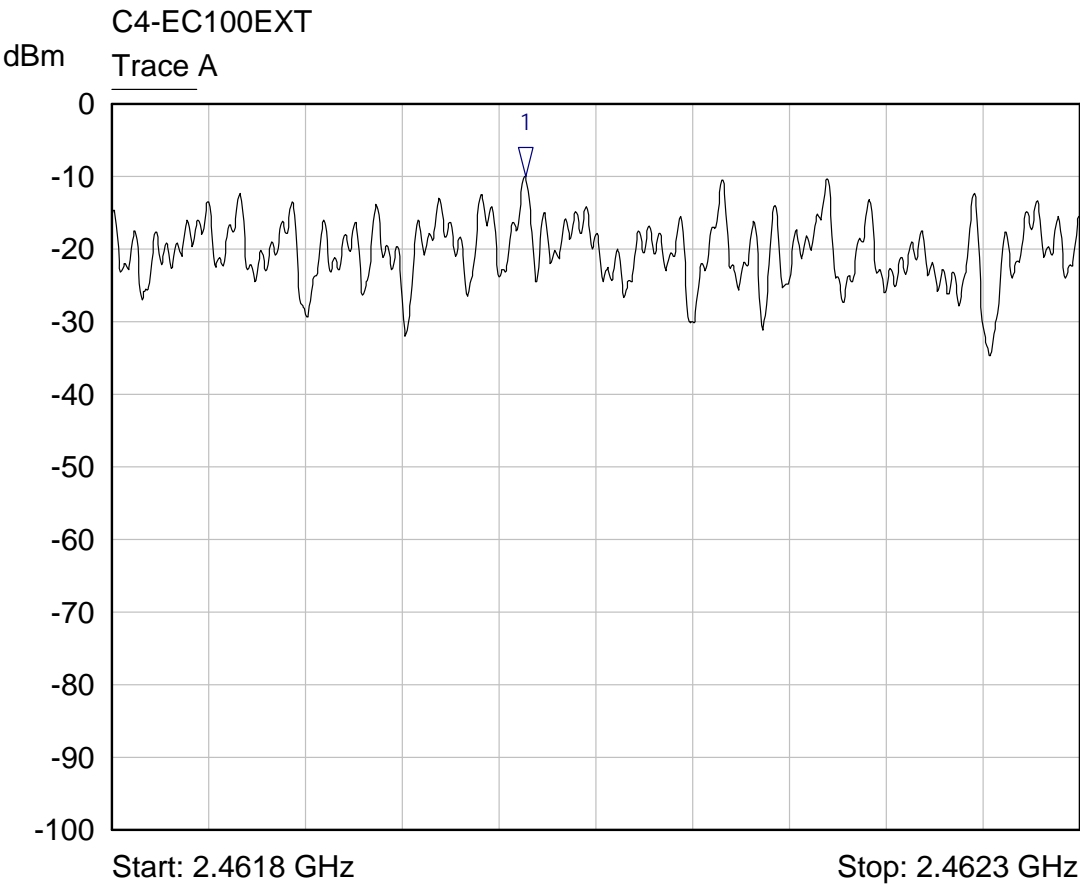
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4142 GHz	-14.56 dBm	

Middle channel – 802.11b



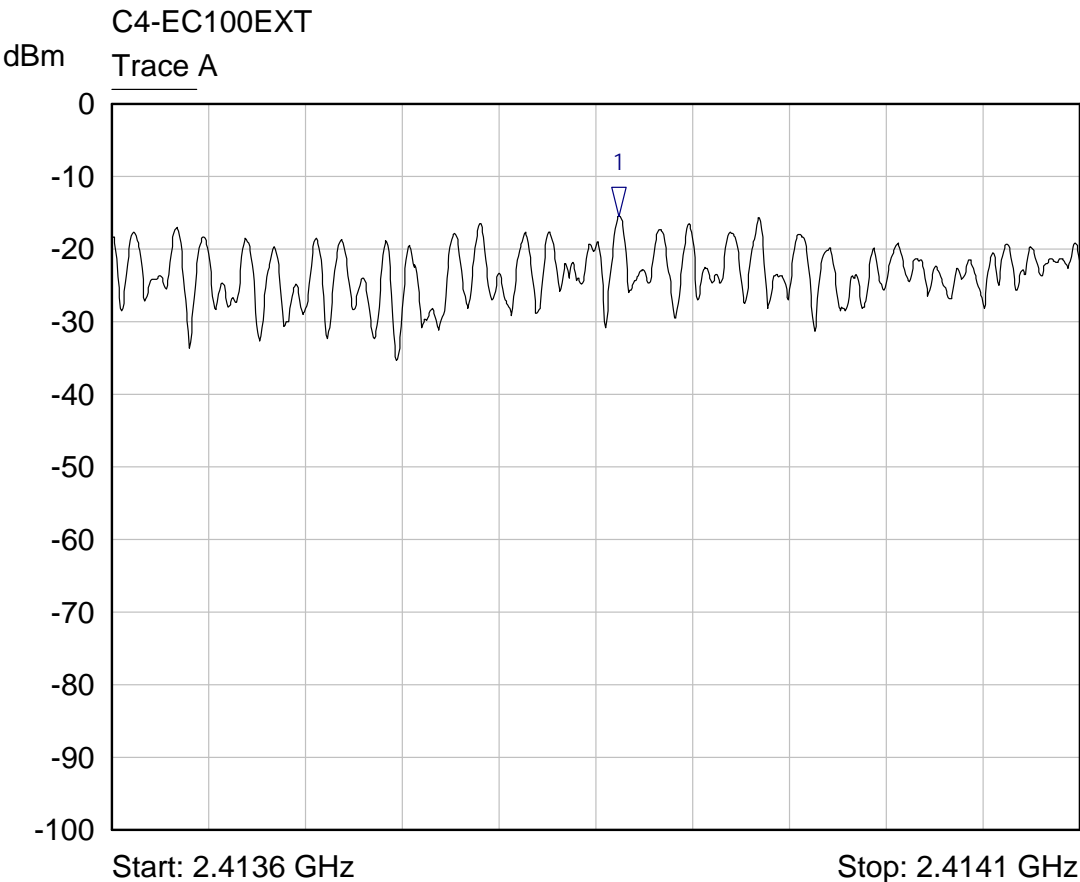
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4397 GHz	-12.46 dBm	

Upper channel – 802.11b



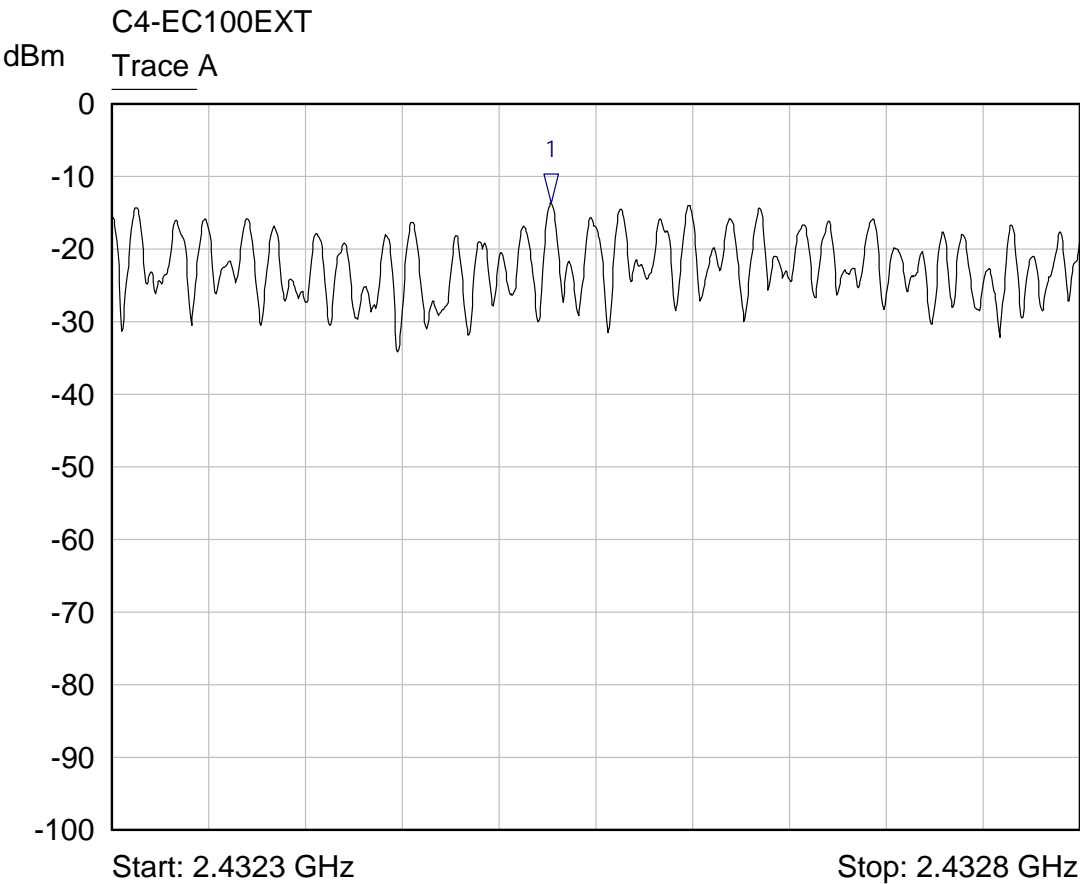
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4620 GHz	-10.00 dBm	

Lower channel – 802.11g



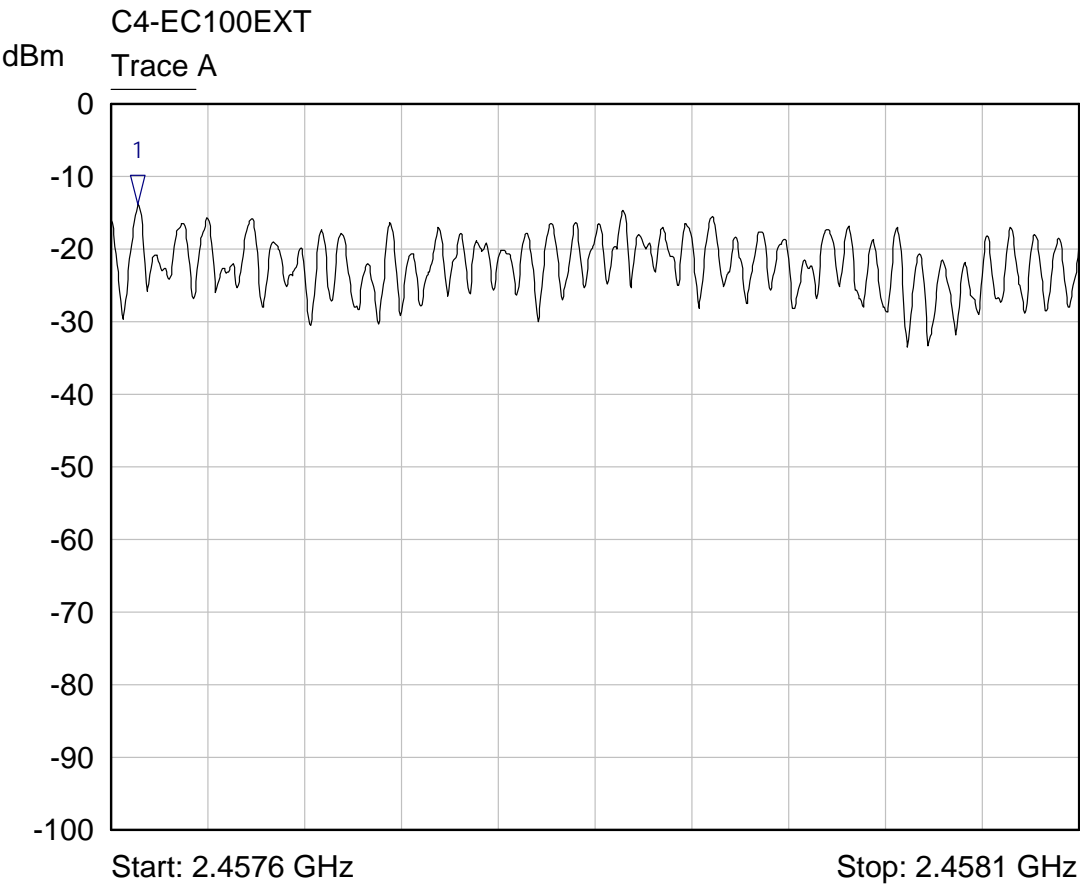
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4138 GHz	-15.54 dBm	

Middle channel – 802.11g



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4325 GHz	-13.67 dBm	

Upper channel – 802.11g



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4576 GHz	-13.91 dBm	

SECTION 7.0 ZIGBEE #1 (260) TRANSCEIVER – MEASUREMENTS AND RESULTS**7.1 General Comments:**

This section contains the test results only. Details of the test methods used and a list of the test equipment used during the measurements can be found in Appendix 1 of this report.

7.2 Test Results**7.2.1 §15.203 Antenna Requirements**

The EUT uses a trace antenna on the PCB and is not user replaceable.

RESULT

The EUT complied with the specification.

7.2.2 §15.207 Conducted Disturbance at the AC Mains Ports

The conducted emissions at the AC mains were measured with the Zigbee#1 transceiver in a constant transmit mode. No difference was seen in the emissions from testing with the 802.11b/g transceiver transmitting constantly. See test data of 6.2.2.

RESULT

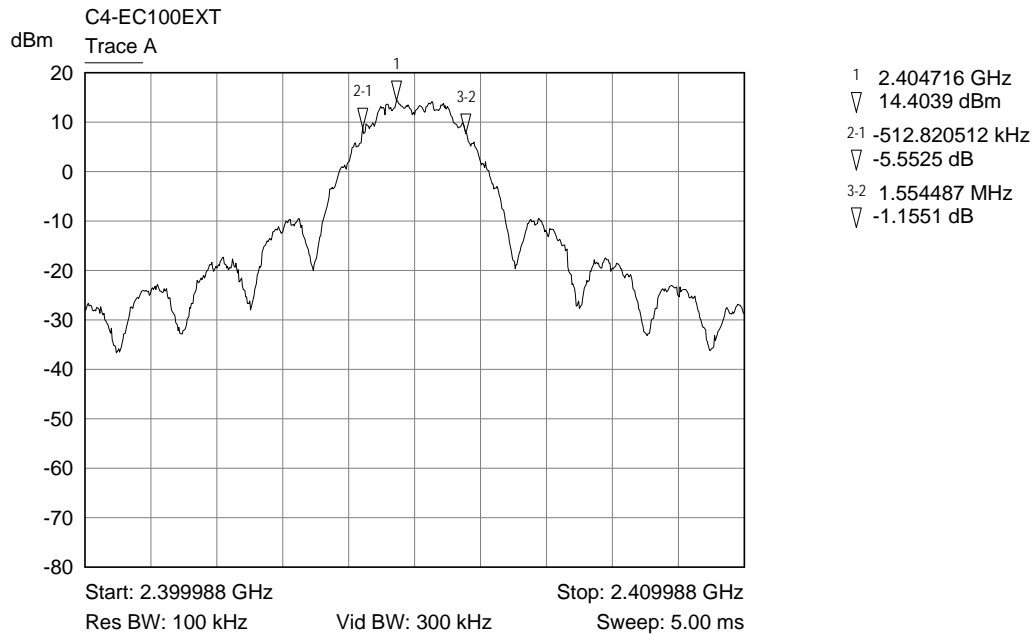
The EUT complied with the specification.

7.2.3 §15.247(a)(2) Emission Bandwidth

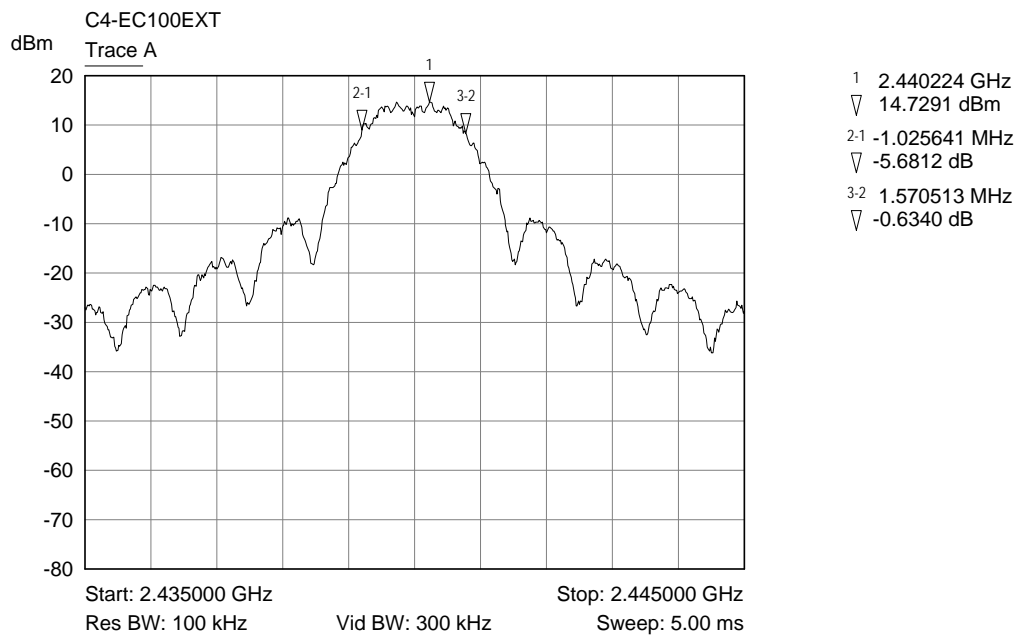
Frequency (MHz)	Emission 6dB Bandwidth (kHz)
2405	1554
2440	1571
2475	1603

RESULT

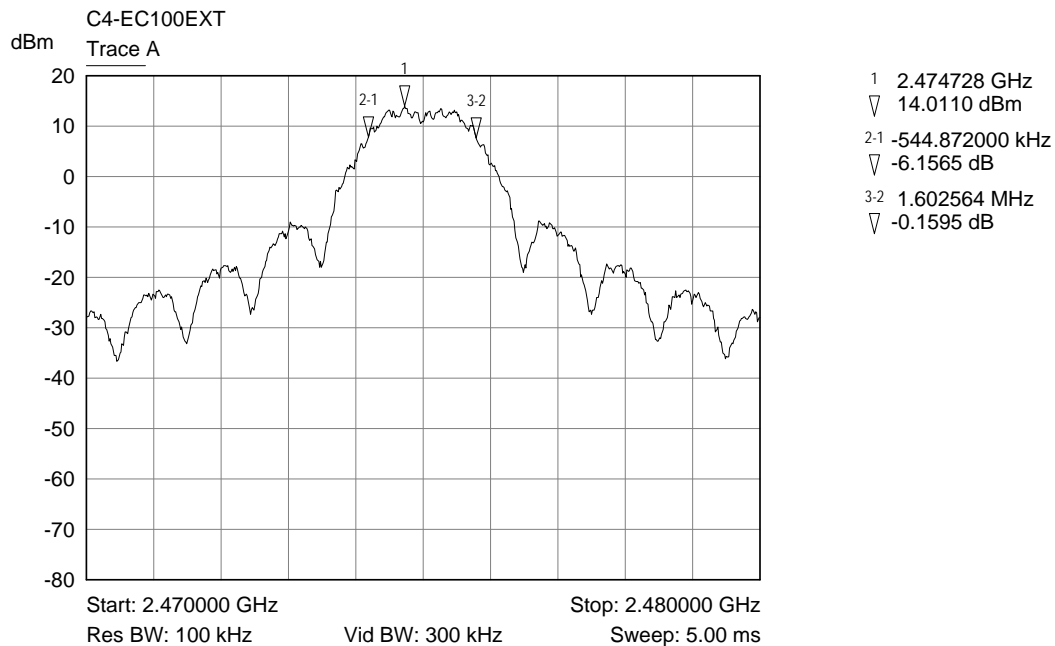
In the configuration tested, the 6 dB bandwidth was greater than 500 kHz; therefore, the EUT complied with the requirements of the specification (see spectrum analyzer plots below).



Trace A Lower channel band width plot



Trace A Middle channel band width plot



Trace A Upper channel band width plot

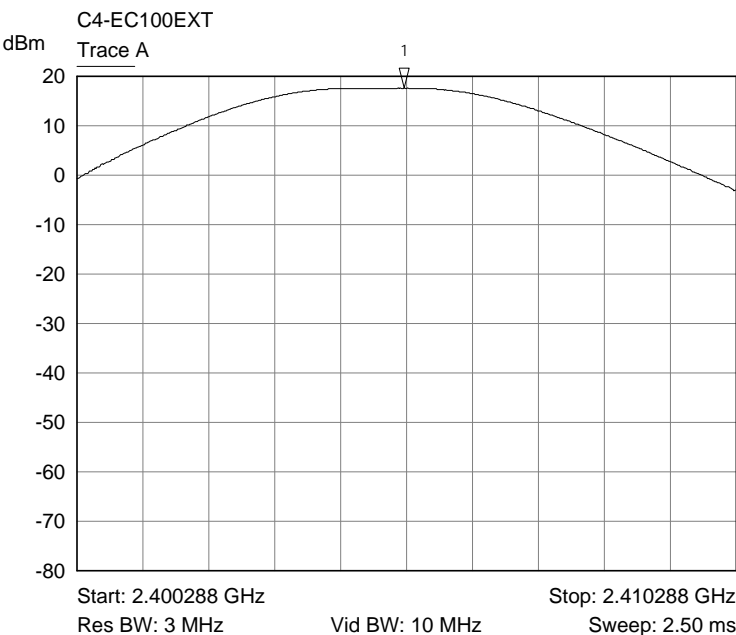
7.2.4 §15.247(b)(3) Peak Output Power

The maximum peak RF Conducted output power measured for this device was 61.7 mW or 17.9 dBm. The limit is 30 dBm or 1 Watt when using antennas with 6 dBi or less gain. The Zigbee #1 antenna has a gain of 0.67 dBi.

Frequency (MHz)	Measured Output Power (dBm)	Measured Output Power (mW)
2405	17.6	57.5
2440	17.9	61.7
2475	17.0	50.1

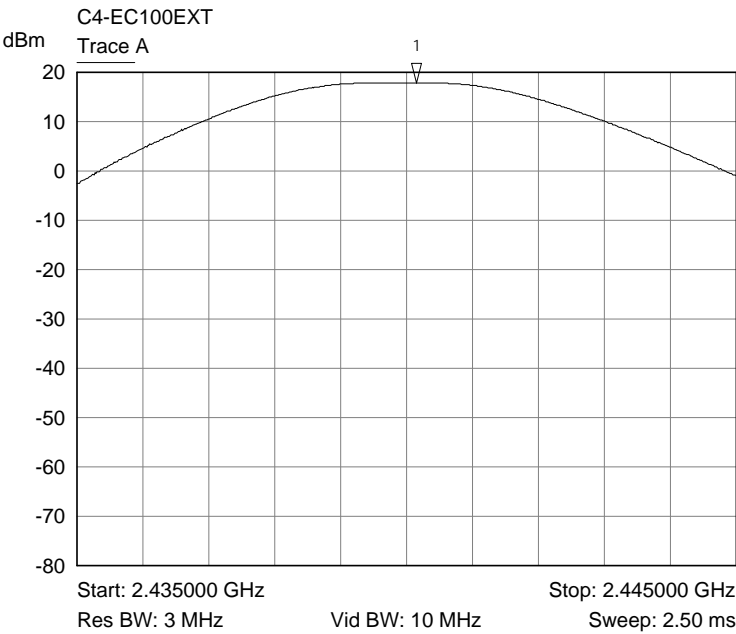
RESULT

In the configuration tested, the RF peak output power was less than 1 Watt; therefore, the EUT complied with the requirements of the specification (see spectrum analyzer plots below).



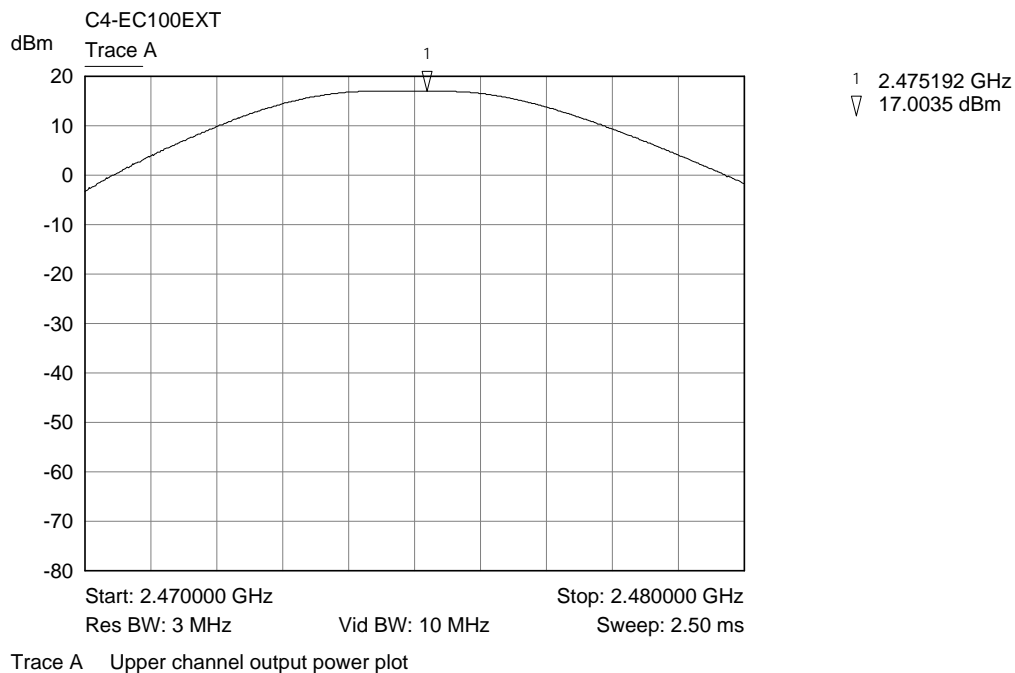
1 2.405256 GHz
▽ 17.6011 dBm

Trace A Lower channel output power plot



1 2.440144 GHz
▽ 17.8529 dBm

Trace A Middle channel output power plot



7.2.5 §15.247(c) Spurious Emissions

7.2.5.1 Conducted Spurious Emissions

The frequency range from 30 MHz to the tenth harmonic of the highest fundamental frequency was investigated to measure any antenna-conducted emissions. Shown below are plots with the EUT tuned to the upper and lower channels. These demonstrate compliance with the provisions of this section at the band edges. The tables following the band edge plots shows the measurement data from spurious emissions noted across the frequency range when transmitting at the lowest frequency, middle frequency, and upper frequency.

The emissions must be attenuated 20 dB below the highest power level measured within the authorized band as measured with a 100 kHz RBW; the highest level measured was 14.7 dBm on Channels 11 to 25; therefore, the criteria is $14.7 - 20.0 = -5.3$ dBm.

RESULT

The EUT complies with the specification.

Transmitting on the Lowest Channel (2.405 GHz)

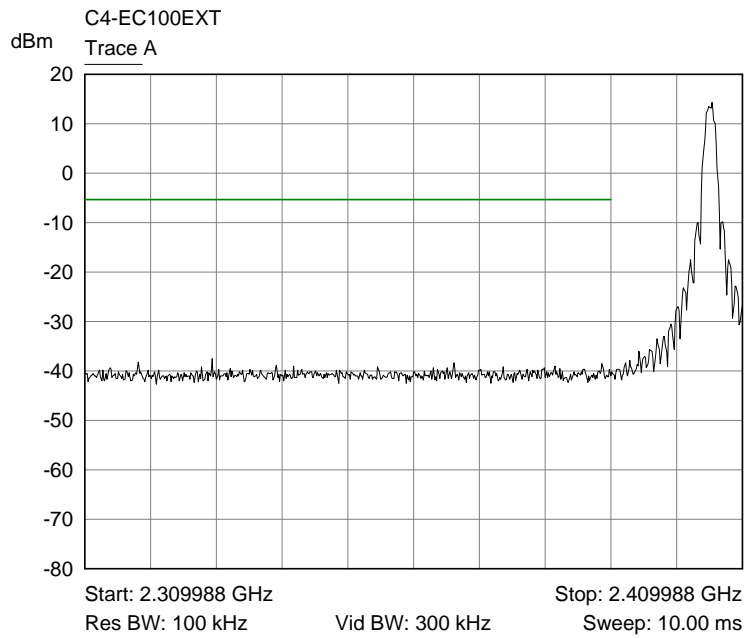
Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4810.0	-43.4	-5.3
7215.0	-62.3	-5.3
9620.0	-56.6	-5.3
12025.0	-70.3	-5.3
14430.0	-67.6	-5.3
16835.0	-73.7	-5.3
19240.0	-74.7	-5.3
21645.0	-74.6	-5.3
24050.0	-73.2	-5.3

Transmitting on the Middle Channel (2.440 GHz)

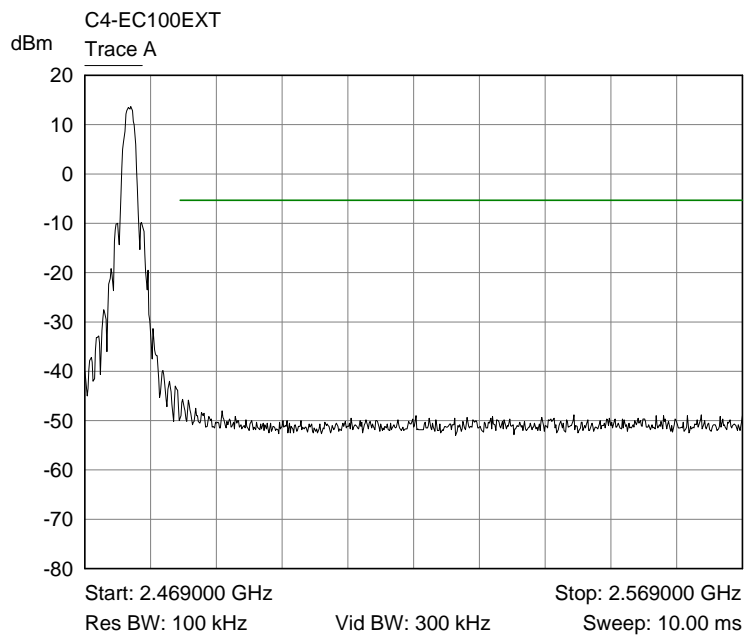
Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4880.0	-38.4	-5.3
7320.0	-61.7	-5.3
9760.0	-54.3	-5.3
12200.0	-76.2	-5.3
14640.0	-68.3	-5.3
17080.0	-74.6	-5.3
19520.0	-75.9	-5.3
21960.0	-75.1	-5.3
24400.0	-73.5	-5.3

Transmitting on the Highest Channel (2.475 GHz)

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4950.0	-36.2	-5.3
7425.0	-61.1	-5.3
9900.0	-55.3	-5.3
12375.0	-69.9	-5.3
14850.0	-67.2	-5.3
17325.0	-74.1	-5.3
19800.0	-74.8	-5.3
22275.0	-75.6	-5.3
24750.0	-72.8	-5.3



Trace A Lower channel band edge plot



Trace A Upper channel band edge plot

7.2.5.2 Radiated Emissions in the Restricted Bands of §15.205

The frequency range from 30 MHz to 25 GHz was investigated to measure any radiated emissions in the restricted bands. Shown below are plots with the EUT tuned to the upper and lower channels. These demonstrate compliance with the provisions of this section at the band edges. The tables following the plots show measurements of any emission that fell into the restricted bands of §15.205. The tables show the worst-case emission measured. For frequencies above 12.5 GHz, a measurement distance of 1 meter was used. The noise floor was a minimum of 6 dB below the limit. The emissions in the restricted bands must meet the limits specified in §15.209.

AVERAGE FACTOR

The EUT operates at a maximum duty cycle of 42.06% when using the EmberZNet protocol. A correction factor of -7.5 dB will be applied to the average detection measurements. For details of the duty cycle calculation, see Appendix 4.

RESULT

All emissions in the restricted bands of §15.205 met the limits specified in §15.209; therefore, the EUT complies with the specification.

Transmitting at the Lowest Frequency (2.405 GHz)

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Averaging Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4810.0	Peak	Vertical	24.6	37.5	0.0	62.1	74.0	-11.9
4810.0	Average	Vertical	20.5	37.5	-7.5	50.5	54.0	-3.5
4810.0	Peak	Horizontal	28.6	37.5	0.0	66.1	74.0	-7.9
4810.0	Average	Horizontal	22.9	37.5	-7.5	52.9	54.0	-1.1
7215.0	Peak	Vertical	19.8	41.4	0.0	61.2	74.0	-12.8
7215.0	Average	Vertical	13.0	41.4	-7.5	46.9	54.0	-7.1
7215.0	Peak	Horizontal	24.5	41.4	0.0	65.9	74.0	-8.1
7215.0	Average	Horizontal	18.3	41.4	-7.5	52.2	54.0	-1.8
12025.0	Peak	Vertical	4.0	46.0	0.0	50.0	74.0	-24.0
12025.0	Average	Vertical	-4.3	46.0	-7.5	34.2	54.0	-19.8
12025.0	Peak	Horizontal	6.8	46.0	0.0	52.8	74.0	-21.2
12025.0	Average	Horizontal	-0.2	46.0	-7.5	38.3	54.0	-15.7

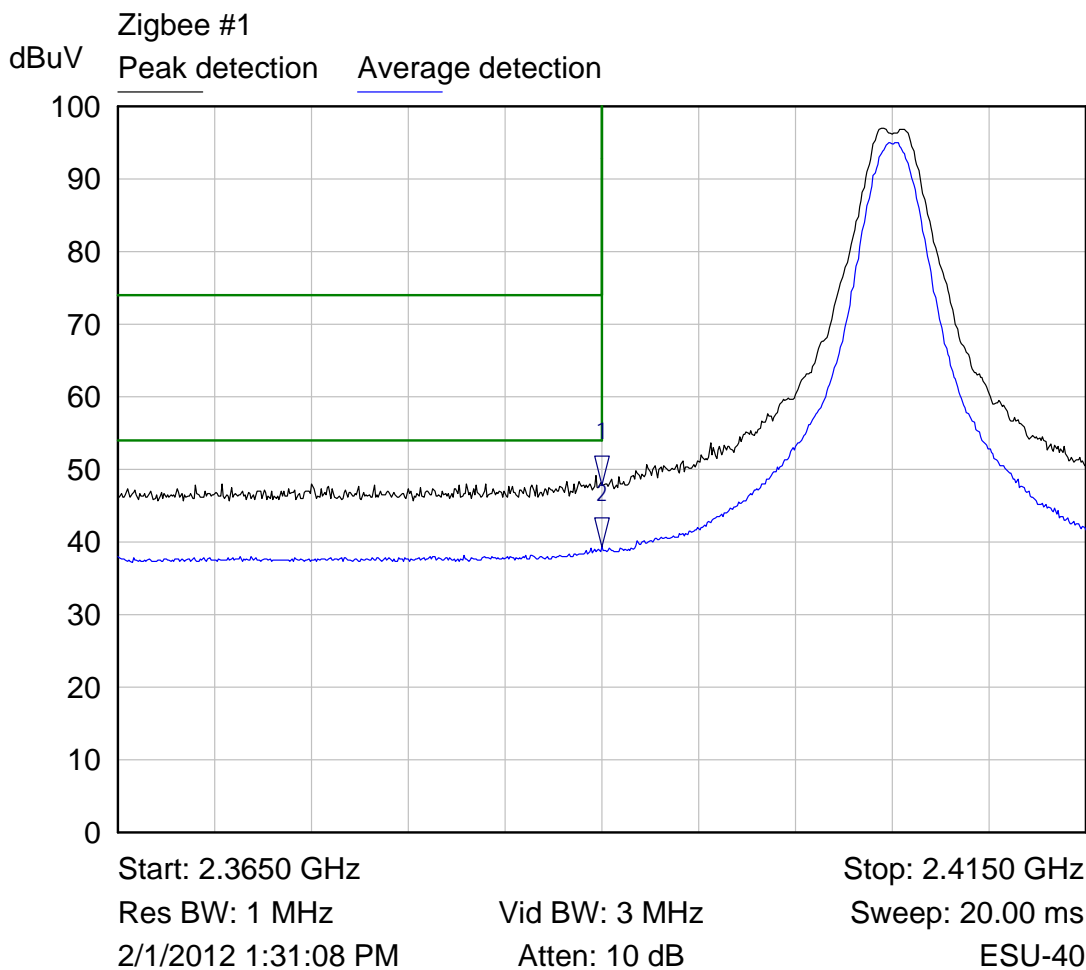
Transmitting at the Middle Frequency (2.440 GHz)

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Averaging Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4880.0	Peak	Vertical	26.8	37.7	0.0	64.5	74.0	-9.5
4880.0	Average	Vertical	21.3	37.7	-7.5	51.5	54.0	-2.5
4880.0	Peak	Horizontal	27.3	37.7	0.0	65.0	74.0	-9.0
4880.0	Average	Horizontal	21.0	37.7	-7.5	51.2	54.0	-2.8
7320.0	Peak	Vertical	22.8	41.7	0.0	64.5	74.0	-9.5
7320.0	Average	Vertical	14.5	41.7	-7.5	48.7	54.0	-5.3
7320.0	Peak	Horizontal	26.4	41.7	0.0	68.1	74.0	-5.9
7320.0	Average	Horizontal	18.1	41.7	-7.5	52.3	54.0	-1.7
12200	Peak	Vertical	4.6	45.7	0.0	50.3	74.0	-23.7
12200	Average	Vertical	-4.0	45.7	-7.5	34.2	54.0	-19.8
12200	Peak	Horizontal	5.8	45.7	0.0	51.5	74.0	-22.5
12200	Average	Horizontal	-4.3	45.7	-7.5	33.9	54.0	-20.1

Transmitting at the Highest Frequency (2.475 GHz)

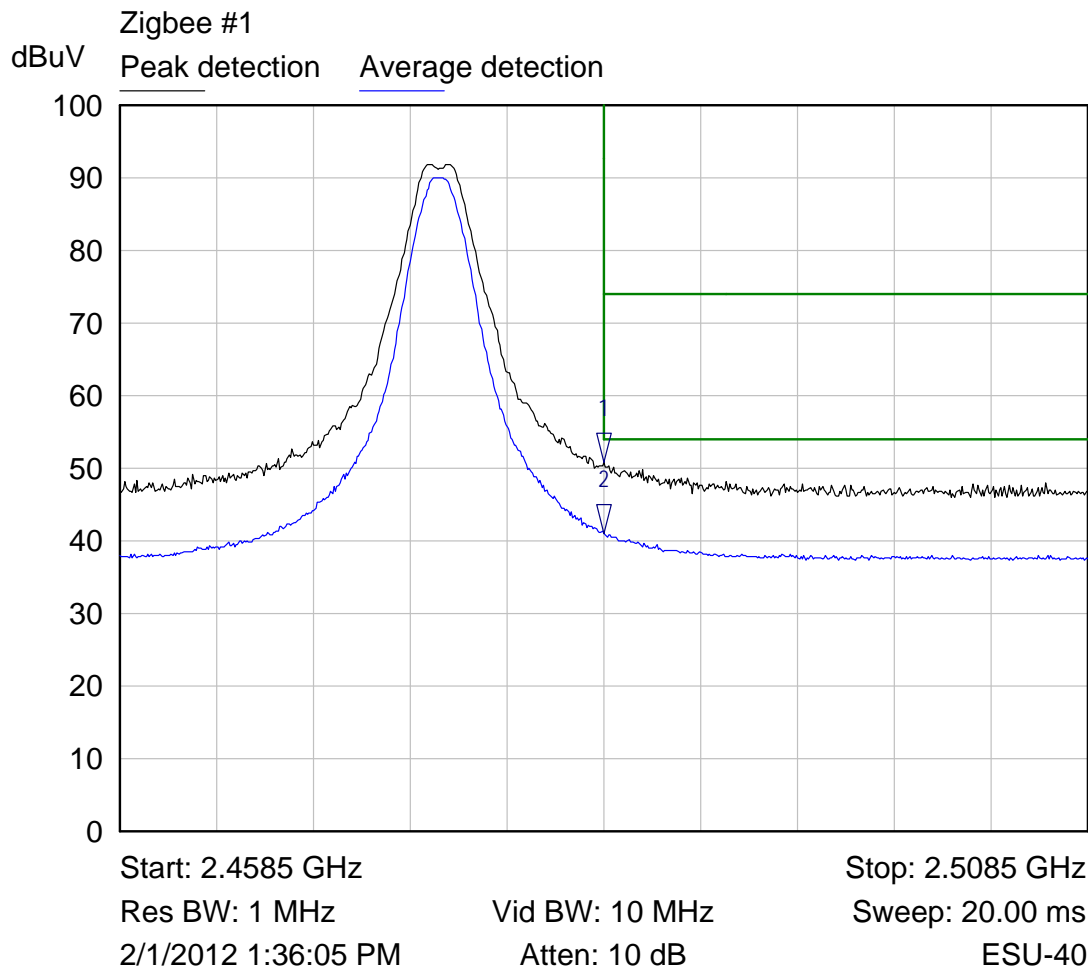
Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Averaging Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4950.0	Peak	Vertical	25.3	37.8	0.0	63.1	74.0	-10.9
4950.0	Average	Vertical	19.5	37.8	-7.5	49.8	54.0	-4.2
4950.0	Peak	Horizontal	26.8	37.8	0.0	64.6	74.0	-9.4
4950.0	Average	Horizontal	20.6	37.8	-7.5	50.9	54.0	-3.1
7425.0	Peak	Vertical	21.4	42.0	0.0	63.4	74.0	-10.6
7425.0	Average	Vertical	13.5	42.0	-7.5	48.0	54.0	-6.0
7425.0	Peak	Horizontal	24.8	42.0	0.0	66.8	74.0	-7.2
7425.0	Average	Horizontal	17.4	42.0	-7.5	51.9	54.0	-2.1
12375.0	Peak	Vertical	5.6	45.4	0.0	51.0	74.0	-23.0
12375.0	Average	Vertical	-3.7	45.4	-7.5	34.2	54.0	-19.8
12375.0	Peak	Horizontal	7.1	45.4	0.0	52.5	74.0	-21.5
12375.0	Average	Horizontal	-0.1	45.4	-7.5	37.8	54.0	-16.2

No other emissions were seen in the restricted bands. Noise floor was greater than 6 dB below the limit. At frequencies above 12.5 GHz, a 1 meter measurement distance was used.



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Peak detection	2.3900 GHz	47.90 dBuV	
2 ▽	Average detection	2.3900 GHz	39.30 dBuV	

260 lower band edge at +3/+10



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Peak detection	2.4835 GHz	50.76 dBuV	
2 ▽	Average detection	2.4835 GHz	41.07 dBuV	

260 upper band edge at +3/+10

7.2.6 §15.247(d) Peak Power Spectral Density

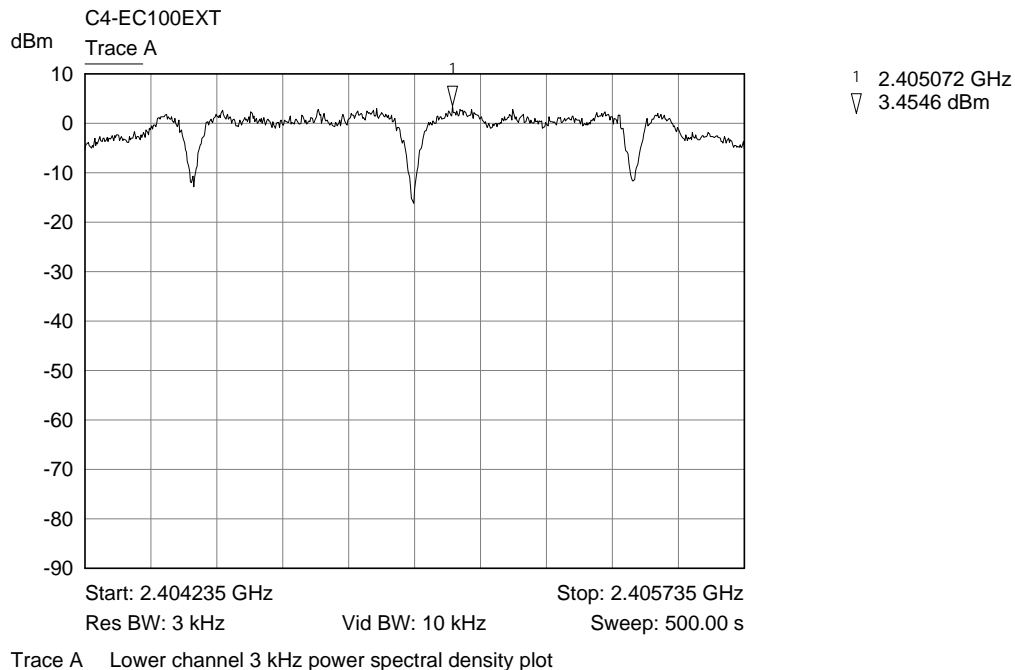
The peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. The plots are shown below and the results of this testing are summarized in the table below.

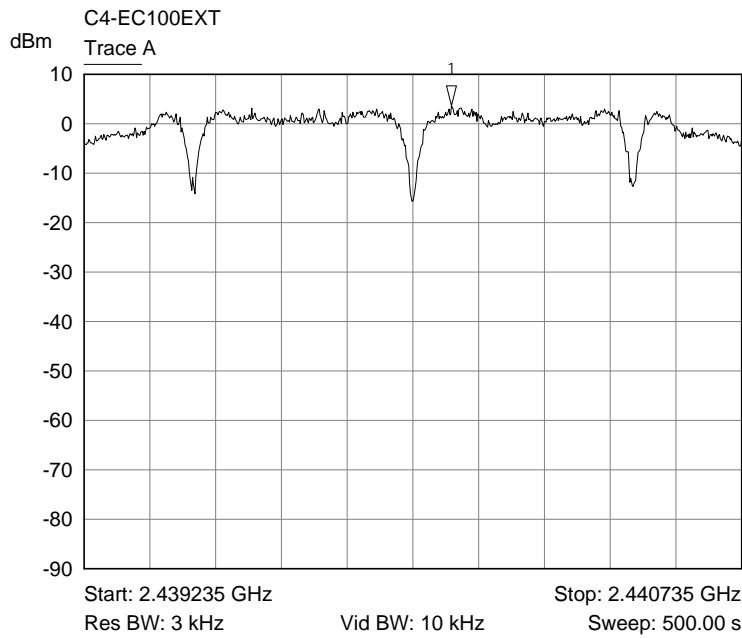
Frequency (MHz)	Measurement (dBm)	Criteria (dBm)	Margin (dBm)
2405	3.5	8.0	-4.5
2440	3.7	8.0	-4.3
2475	2.6	8.0	-5.4

A diagram of the test setup is included in Appendix 1. The spectrum analyzer RBW was set to 3 kHz and the VBW set greater than the RBW. The span was set to 1.5 MHz and the sweep was set to 500 seconds (Sweep = (Span/3 kHz)).

RESULT

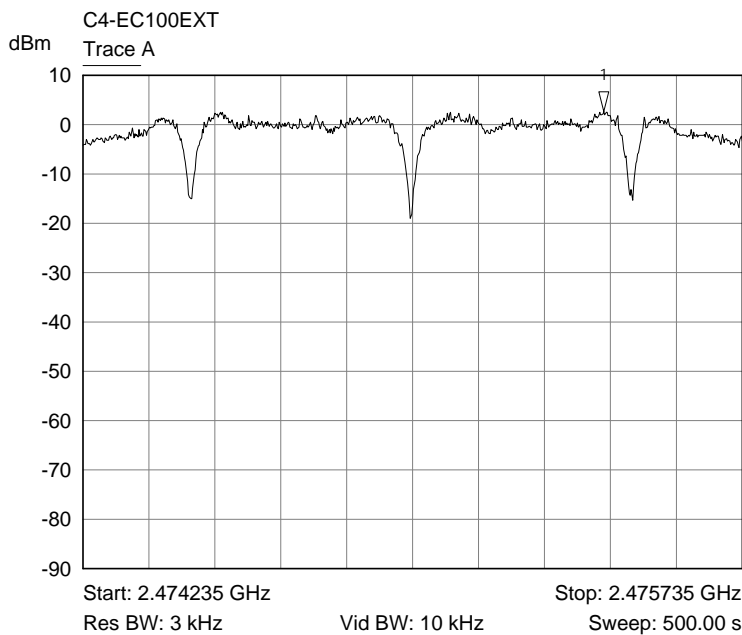
The EUT complies with the specification.





1 2.440074 GHz
▽ 3.7294 dBm

Trace A Middle channel 3 kHz power spectral density plot



1 2.475420 GHz
▽ 2.6126 dBm

Trace A Upper channel 3 kHz power spectral density plot

SECTION 8.0 ZIGBEE #2 (357) TRANSCEIVER – MEASUREMENTS AND RESULTS**8.1 General Comments:**

This section contains the test results only. Details of the test methods used and a list of the test equipment used during the measurements can be found in Appendix 1 of this report.

8.2 Test Results:**8.2.1 §15.203 Antenna Requirements**

The EUT uses an antenna with a maximum gain of 2.5 dBi, ¼ wave, dipole that mounts internally via a coaxial cable to a connector on the PCB of the EUT. The antenna is not user replaceable.

RESULT

The EUT complied with the specification.

8.2.2 §15.207 Conducted Disturbance at the AC Mains Ports

The conducted emissions at the AC mains were measured with the Zigbee#2 transceiver in a constant transmit mode. No difference was seen in the emissions from testing with the 802.11b/g transceiver transmitting constantly. See test data of 6.2.2.

RESULT

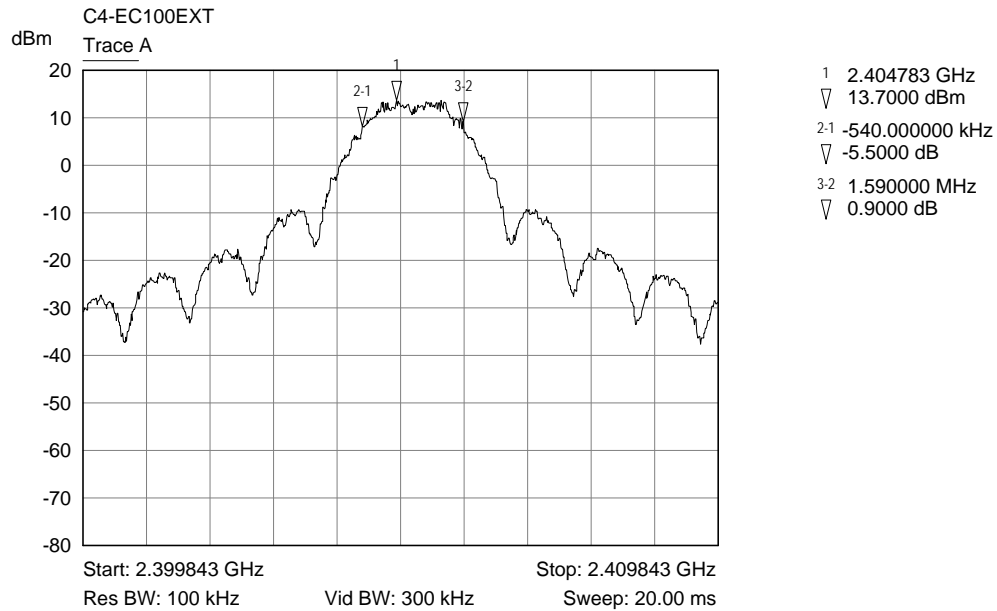
The EUT complied with the specification.

8.2.3 §15.247(a)(2) Emission Bandwidth

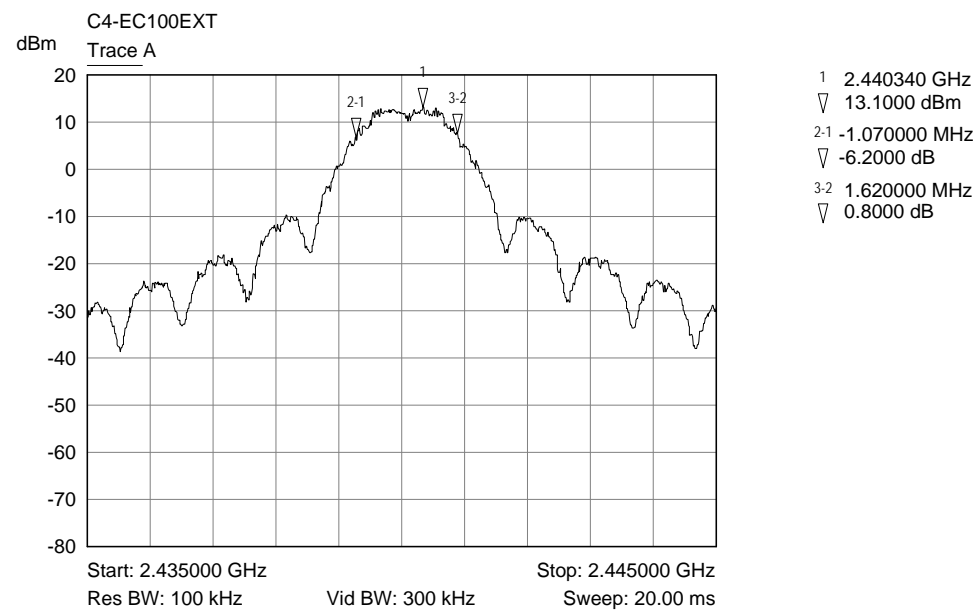
Frequency (MHz)	Emission 6dB Bandwidth (kHz)
2405	1590
2440	1620
2475	1620

RESULT

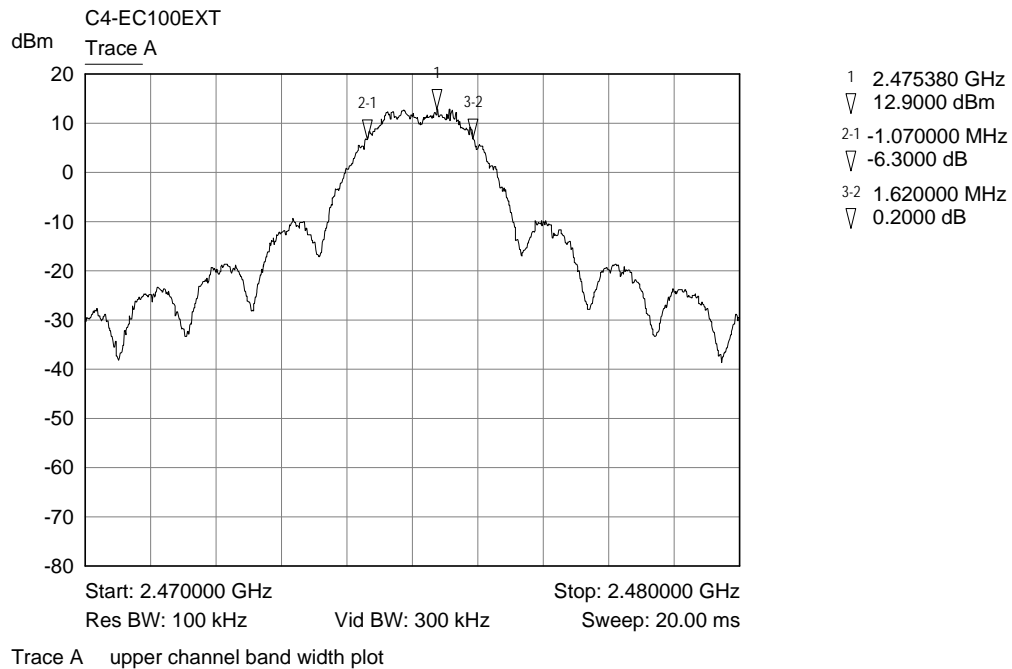
In the configuration tested, the 6 dB bandwidth was greater than 500 kHz; therefore, the EUT complied with the requirements of the specification (see spectrum analyzer plots below).



Trace A lower channel bandwidth plot



Trace A middle channel band width plot



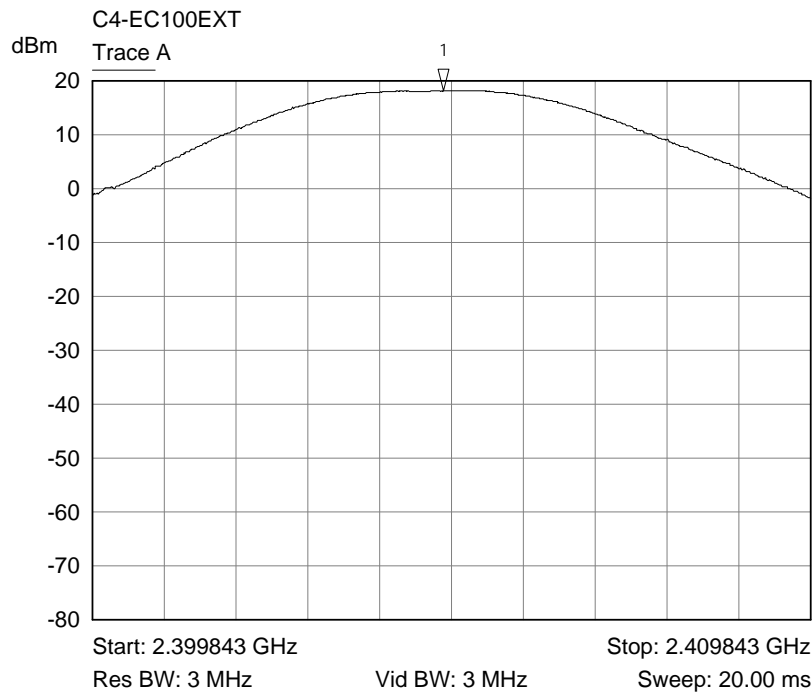
8.2.4 §15.247(b)(3) Peak Output Power

The maximum peak RF Conducted output power measured for this device was 66.07 mW or 18.2 dBm. The limit is 30 dBm or 1 Watt when using antennas with 6 dBi or less gain. The Zigbee #2 antenna has a gain of 2.5 dBi.

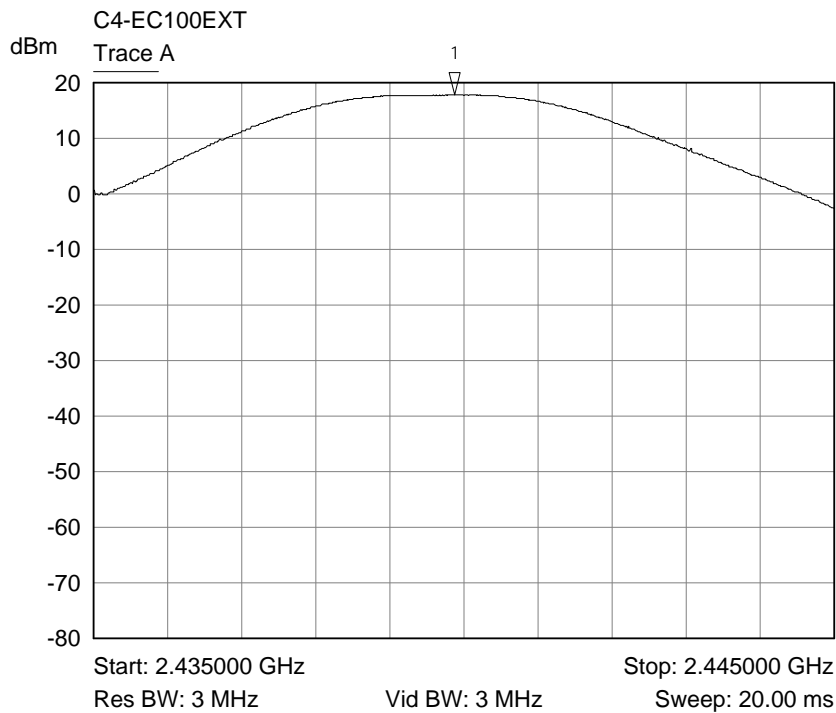
Frequency (MHz)	Measured Output Power (dBm)	Measured Output Power (mW)
2405	18.2	66.07
2440	17.9	61.66
2475	17.6	57.54

RESULT

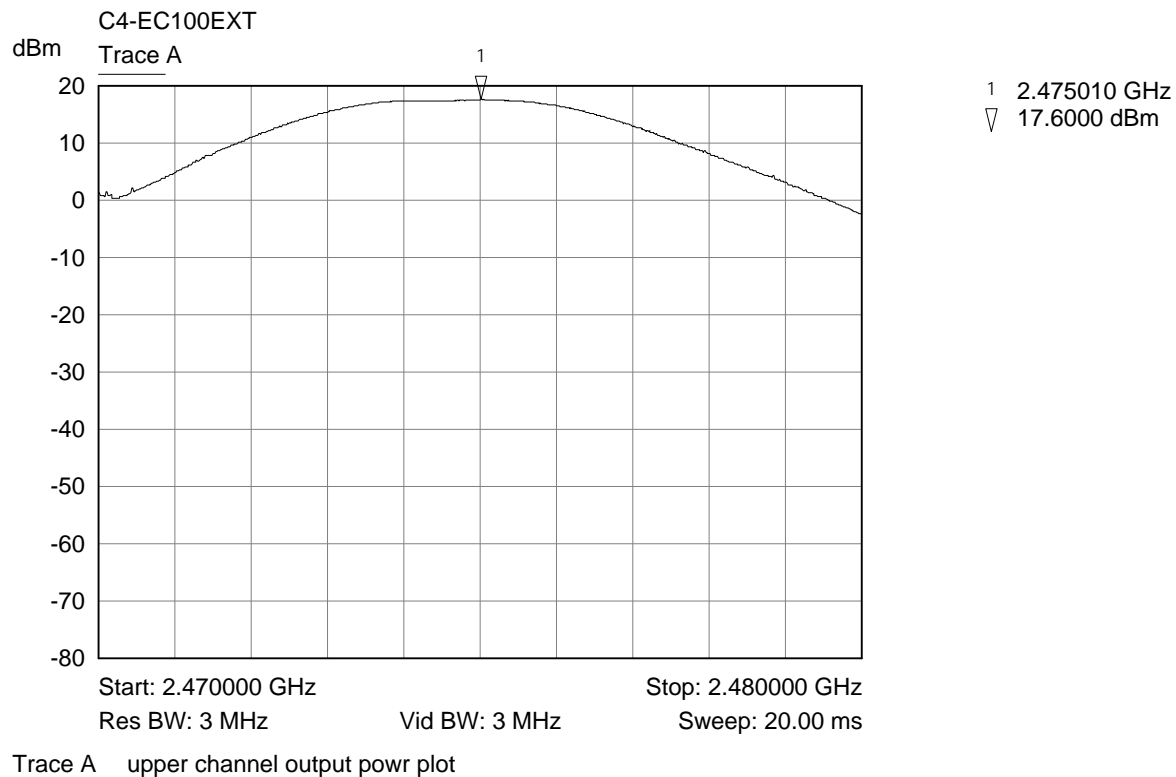
In the configuration tested, the RF peak output power was less than 1 Watt; therefore, the EUT complied with the requirements of the specification (see spectrum analyzer plots below).



Trace A lower channel output power plot



Trace A middle channel output power plot



8.2.5 §15.247(c) Spurious Emissions

8.2.5.1 Conducted Spurious Emissions

The frequency range from 30 MHz to the tenth harmonic of the highest fundamental frequency was investigated to measure any antenna-conducted emissions. Shown below are plots with the EUT tuned to the upper and lower channels. These demonstrate compliance with the provisions of this section at the band edges. The tables following the band edge plots shows the measurement data from spurious emissions noted across the frequency range when transmitting at the lowest frequency, middle frequency, and upper frequency.

The emissions must be attenuated 20 dB below the highest power level measured within the authorized band as measured with a 100 kHz RBW; the highest level measured was 13.4 dBm; therefore, the criteria is $13.4 - 20.0 = -6.6$ dBm.

RESULT

The EUT complies with the specification.

Transmitting on the Lowest Channel (2.405 GHz)

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4810.0	-50.3	-6.6
7215.0	-62.4	-6.6
9620.0	-64.6	-6.6
12025.0	-70.1	-6.6
14430.0	-64.7	-6.6
16835.0	-64.6	-6.6
19240.0	-61.8	-6.6
21645.0	-60.4	-6.6
24050.0	-58.0	-6.6

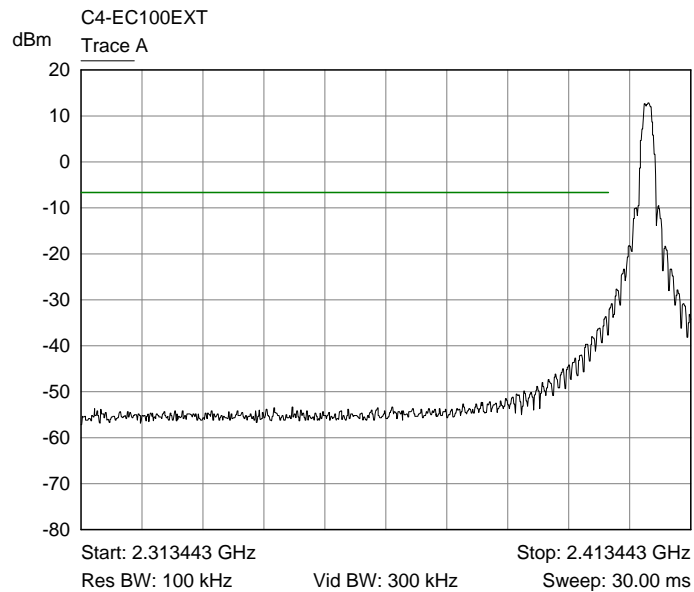
Transmitting on the Middle Channel (2.440 GHz)

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4880.0	-55.3	-6.6
7320.0	-65.6	-6.6
9760.0	-63.2	-6.6
12200.0	-71.3	-6.6
14640.0	-64.7	-6.6
17080.0	-65.3	-6.6
19520.0	-62.0	-6.6
21960.0	-60.3	-6.6
24400.0	-58.0	-6.6

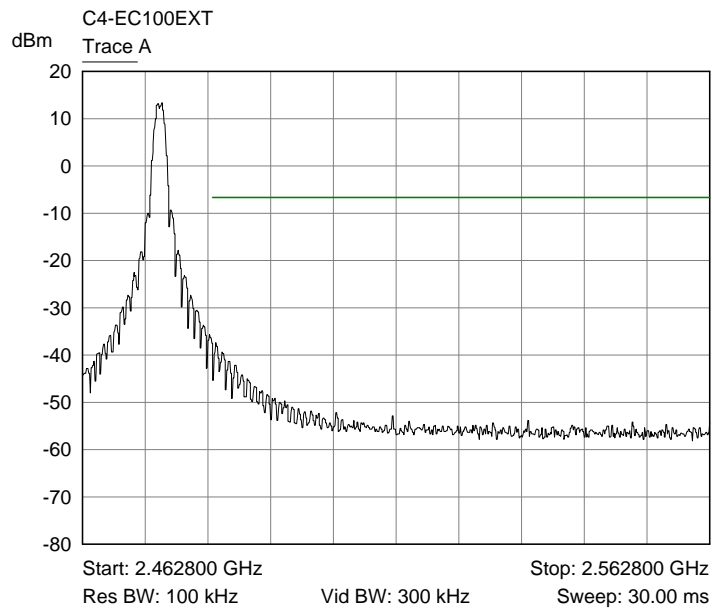
Transmitting on the Highest Channel (2.475 GHz)

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4950	-57.7	-6.6
7425	-68.4	-6.6
9900	-66.1	-6.6
12375	-70.0	-6.6
14850	-63.6	-6.6

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
17325	-65.5	-6.6
19800	-62.1	-6.6
22275	-58.3	-6.6
24750	-58.0	-6.6



Trace A lower channel lower band edge plot



Trace A upper channel band edge plot

8.2.5.2 Radiated Emissions in the Restricted Bands of §15.205

The frequency range from 30 MHz to 25 GHz was investigated to measure any radiated emissions in the restricted bands. Shown below are plots with the EUT tuned to the upper and lower channels. These demonstrate compliance with the provisions of this section at the band edges. The tables following the plots show measurements of any emission that fell into the restricted bands of §15.205. The tables show the worst-case emission measured. For frequencies above 12.5 GHz, a measurement distance of 1 meter was used. The noise floor was a minimum of 6 dB below the limit. The emissions in the restricted bands must meet the limits specified in §15.209.

AVERAGE FACTOR

The EUT operates at a maximum duty cycle of 42.06% when using the EmberZNet protocol. A correction factor of -7.5 dB will be applied to the average detection measurements. For details of the duty cycle calculation, see Appendix 4.

RESULT

All emissions in the restricted bands of §15.205 met the limits specified in §15.209; therefore, the EUT complies with the specification.

Transmitting at the Lowest Frequency (2.405 GHz)

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Averaging Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4810.0	Peak	Vertical	19.1	37.7	0.0	56.8	74.0	-17.2
4810.0	Average	Vertical	11.0	37.7	-7.5	41.2	54.0	-12.8
4810.0	Peak	Horizontal	24.7	37.7	0.0	62.4	74.0	-11.6
4810.0	Average	Horizontal	17.4	37.7	-7.5	47.6	54.0	-6.4
7215.0	Peak	Vertical	20.4	42.1	0.0	62.5	74.0	-11.5
7215.0	Average	Vertical	12.5	42.1	-7.5	47.1	54.0	-6.9
7215.0	Peak	Horizontal	20.2	42.1	0.0	62.3	74.0	-11.7
7215.0	Average	Horizontal	15.8	42.1	-7.5	50.4	54.0	-3.6
12025.0	Peak	Vertical	12.8	47.2	0.0	60.0	74.0	-14.0
12025.0	Average	Vertical	3.0	47.2	-7.5	42.7	54.0	-11.3
12025.0	Peak	Horizontal	8.7	47.2	0.0	55.9	74.0	-18.1
12025.0	Average	Horizontal	3.1	47.2	-7.5	42.8	54.0	-11.2

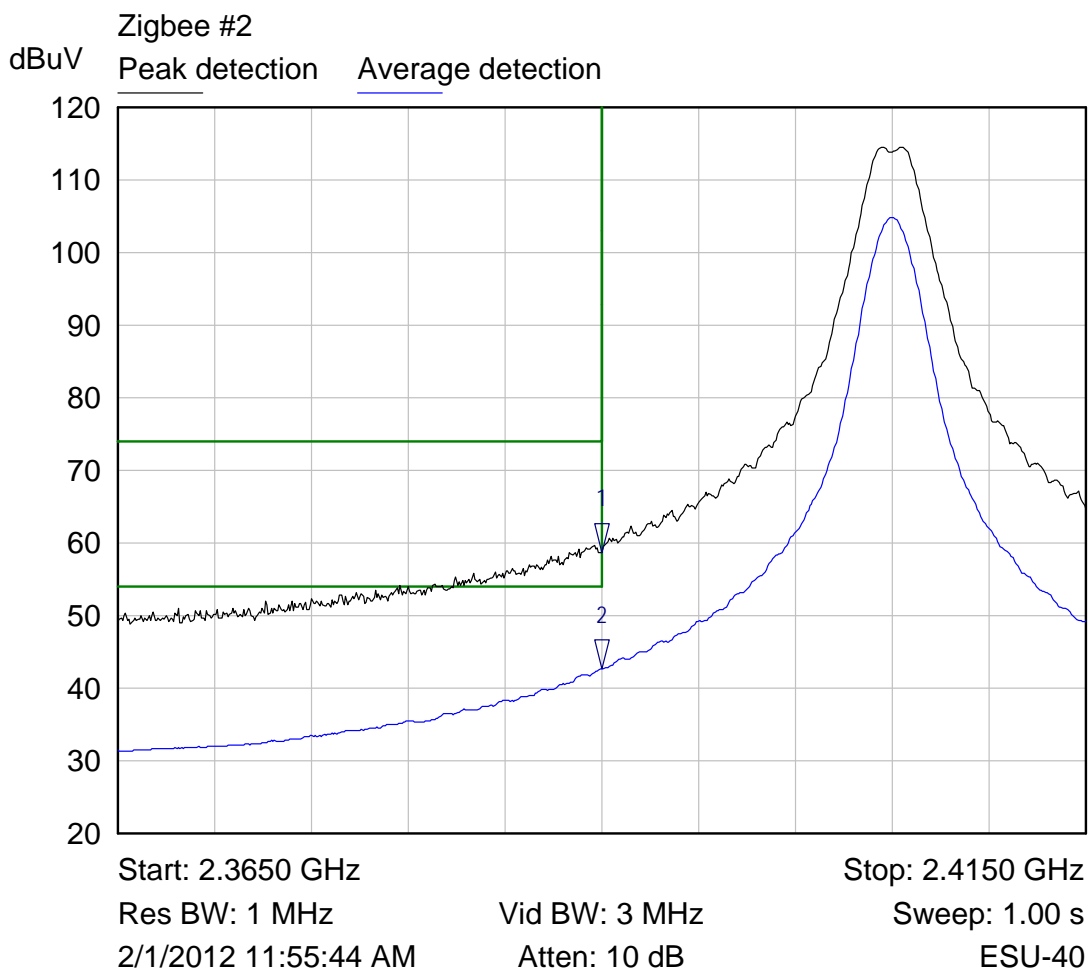
Transmitting at the Middle Frequency (2.440 GHz)

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Averaging Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4880.0	Peak	Vertical	23.2	37.9	0.0	61.1	74.0	-12.9
4880.0	Average	Vertical	17.2	37.9	-7.5	47.6	54.0	-6.4
4880.0	Peak	Horizontal	24.2	37.9	0.0	62.1	74.0	-11.9
4880.0	Average	Horizontal	18.3	37.9	-7.5	48.7	54.0	-5.3
7320.0	Peak	Vertical	18.2	42.3	0.0	60.5	74.0	-13.5
7320.0	Average	Vertical	11.3	42.3	-7.5	46.1	54.0	-7.9
7320.0	Peak	Horizontal	20.9	42.3	0.0	63.2	74.0	-10.8
7320.0	Average	Horizontal	14.5	42.3	-7.5	49.3	54.0	-4.7
12200	Peak	Vertical	2.9	47.1	0.0	50.0	74.0	-24.0
12200	Average	Vertical	-6.7	47.1	-7.5	32.9	54.0	-21.1
12200	Peak	Horizontal	3.0	47.1	0.0	50.1	74.0	-23.9
12200	Average	Horizontal	-5.2	47.1	-7.5	34.4	54.0	-19.6

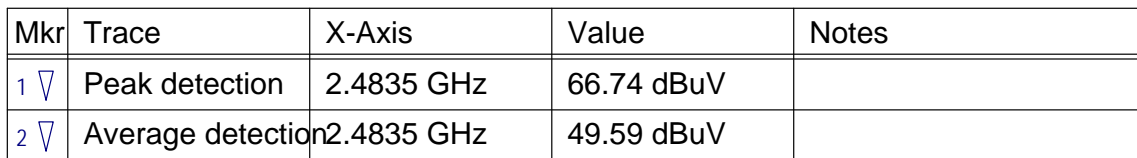
Transmitting at the Highest Frequency (2.475 GHz)

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Averaging Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4950	Peak	Vertical	20.1	38.0	0.0	58.1	74.0	-15.9
4950	Average	Vertical	13.9	38.0	-7.5	44.4	54.0	-9.6
4950	Peak	Horizontal	21.7	38.0	0.0	59.7	74.0	-14.3
4950	Average	Horizontal	16.4	38.0	-7.5	46.9	54.0	-7.1
7425	Peak	Vertical	18.1	42.6	0.0	60.7	74.0	-13.3
7425	Average	Vertical	11.5	42.6	-7.5	46.6	54.0	-7.4
7425	Peak	Horizontal	19.8	42.6	0.0	62.4	74.0	-11.6
7425	Average	Horizontal	14.0	42.6	-7.5	49.1	54.0	-4.9
12375	Peak	Vertical	5.4	47.0	0.0	52.4	74.0	-21.6
12375	Average	Vertical	-2.3	47.0	-7.5	37.2	54.0	-16.8
12375	Peak	Horizontal	9.5	47.0	0.0	56.5	74.0	-17.5
12375	Average	Horizontal	2.5	47.0	-7.5	42.0	54.0	-12.0

No other emissions were seen in the restricted bands. Noise floor was greater than 6 dB below the limit. At frequencies above 12.5 GHz, a 1 meter measurement distance was used.



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Peak detection	2.3900 GHz	58.67 dBuV	
2 ▽	Average detection	2.3900 GHz	42.71 dBuV	



8.2.6 §15.247(d) Peak Power Spectral Density

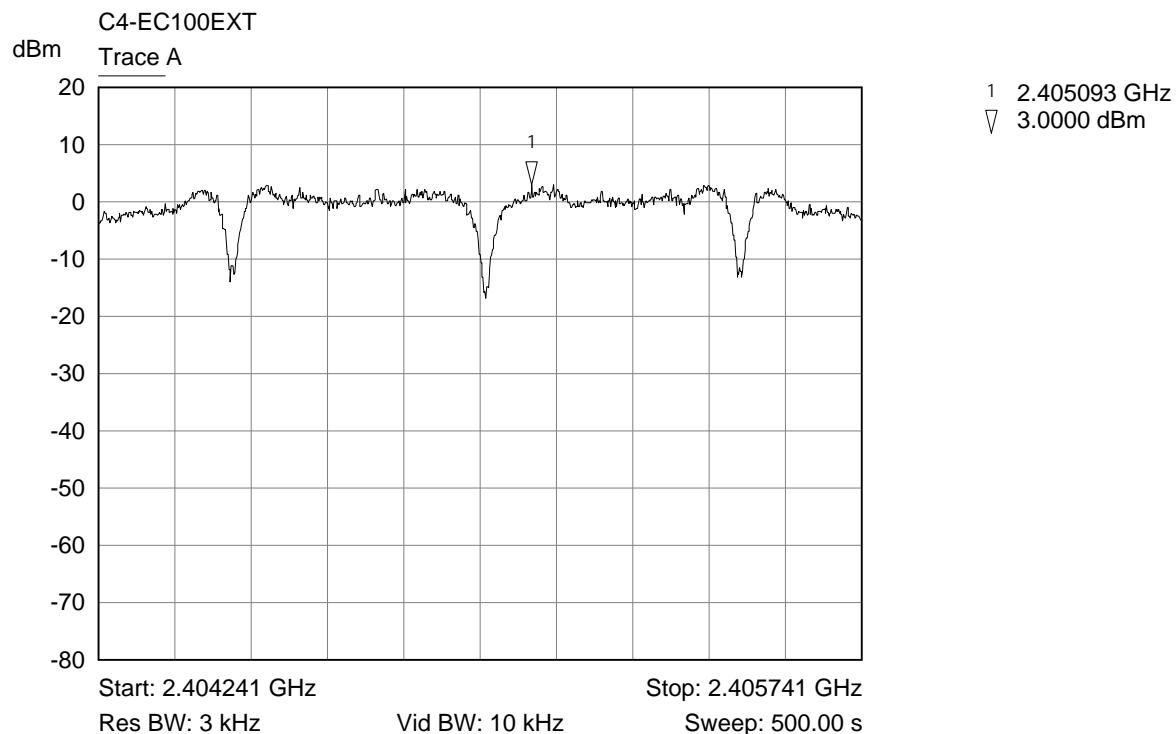
The peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. The plots are shown below and the results of this testing are summarized in the table below.

Frequency (MHz)	Measurement (dBm)	Criteria (dBm)	Margin (dBm)
2405	3.0	8.0	-5.0
2440	3.4	8.0	-4.6
2475	2.8	8.0	-5.2

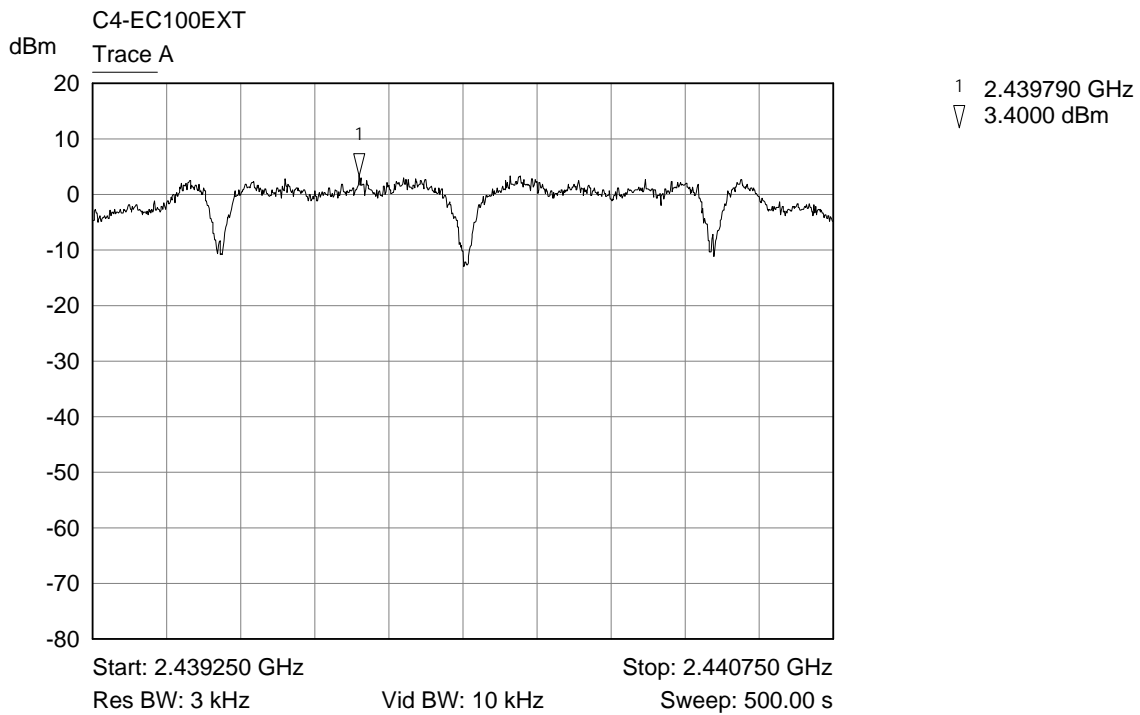
A diagram of the test setup is included in Appendix 1. The spectrum analyzer RBW was set to 3 kHz and the VBW set greater than the RBW. The span was set to 1.5 MHz and the sweep was set to 500 seconds (Sweep = (Span/3 kHz)).

RESULT

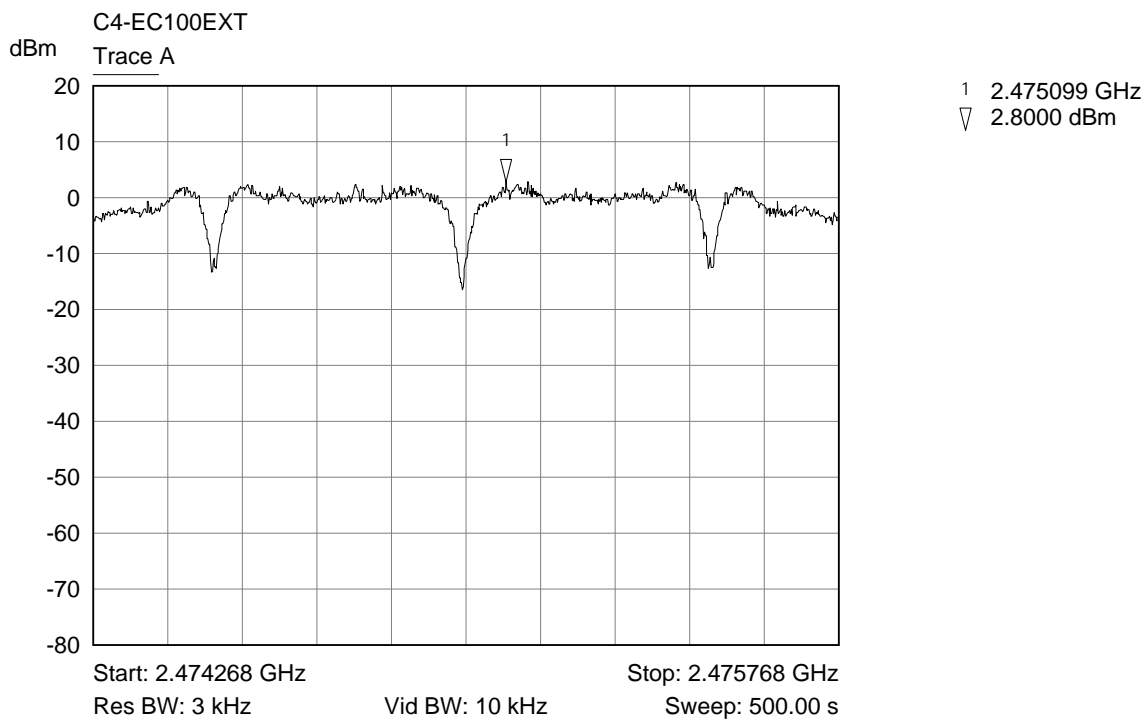
The EUT complies with the specification.



Trace A lower channel 3kHz power spectral density plot



Trace A middle channel 3kHz power spectral density plot



Trace A upper channel 3kHz power spectral density plot

APPENDIX 1 TEST PROCEDURES AND TEST EQUIPMENT**A1.1 §15.207 Conducted Disturbance at the AC Mains**

The conducted disturbance at mains ports from the EUT was measured using a spectrum analyzer with a quasi-peak adapter for peak, quasi-peak and average readings. The quasi-peak adapter uses a bandwidth of 9 kHz, with the spectrum analyzer's resolution bandwidth set at 100 kHz, for readings in the 150 kHz to 30 MHz frequency ranges.

The conducted disturbance at mains ports measurements are performed in a screen room using a (50 Ω /50 μ H) Line Impedance Stabilization Network (LISN).

Where mains flexible power cords are longer than 1 m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0.4 m in length.

Where the EUT is a collection of equipment with each device having its own power cord, the point of connection for the LISN is determined from the following rules:

- a) Each power cord, which is terminated in a mains supply plug, shall be tested separately.
- b) Power cords, which are not specified by the manufacturer to be connected via a host unit, shall be tested separately.
- c) Power cords which are specified by the manufacturer to be connected via a host unit or other power supplying equipment shall be connected to that host unit and the power cords of that host unit connected to the LISN and tested.
- d) Where a special connection is specified, the necessary hardware to effect the connection is supplied by the manufacturer for the testing purpose.
- e) When testing equipment with multiple mains cords, those cords not under test are connected to an artificial mains network (AMN) different than the AMN used for the mains cord under test.

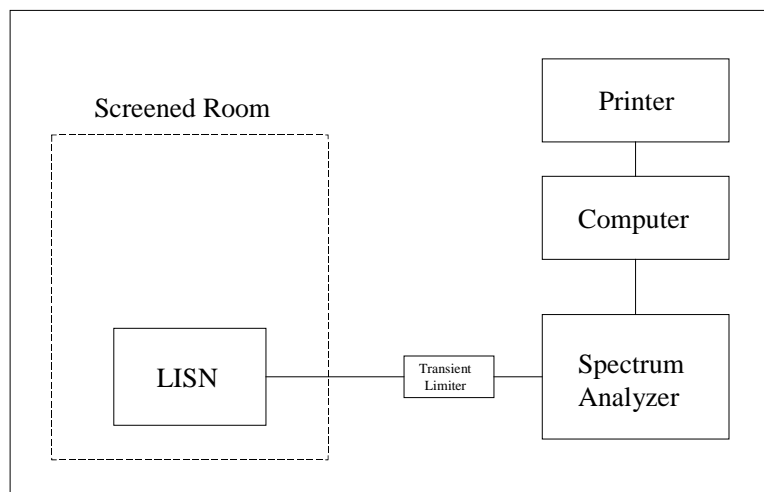
For AC mains port testing the desktop EUT are placed on a non-conducting table at least 0.8 meters from the metallic floor. The equipment is placed a minimum of 40 cm from all walls. Floor standing equipment is placed directly on the earth grounded floor.

Type of Equipment	Manufacturer	Model Number	Serial Number	Date of Last Calibration
Wanship Open Area Test Site #2	Nemko-CCL, Inc.	N/A	N/A	11/16/2011
Test Software	Nemko-CCL, Inc.	Conducted Emissions	Revision 1.2	N/A
Spectrum Analyzer	Hewlett Packard	8566B	2230A01711	01/17/2012
Quasi-Peak Detector	Hewlett Packard	85650A	2043A00137	01/18/2012

Type of Equipment	Manufacturer	Model Number	Serial Number	Date of Last Calibration
LISN	EMCO	3825/2	9305-2099	03/07/2011
Conductance Cable Wanship Site #2	Nemko-CCL, Inc.	Cable J	N/A	12/14/2011
Transient Limiter	Hewlett Packard	11947A	3107A02266	12/14/2011

An independent calibration laboratory or Nemko-CCL, Inc. personnel calibrates all the equipment listed above at intervals defined in ANSI C63.4:2003 Section 4.4 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to tractability is on file and is available for examination upon request.

Conducted Emissions Test Setup



A1.2 §15.247(a)(2) Emission Bandwidth

The EUT was directly connected to the spectrum analyzer via the antenna output port as shown in the block diagram below.

The measurements were performed on three channels, as per 47 CFR 15.31(m), one near the bottom of the spectrum, one near the middle of the spectrum and one near the top of the spectrum.

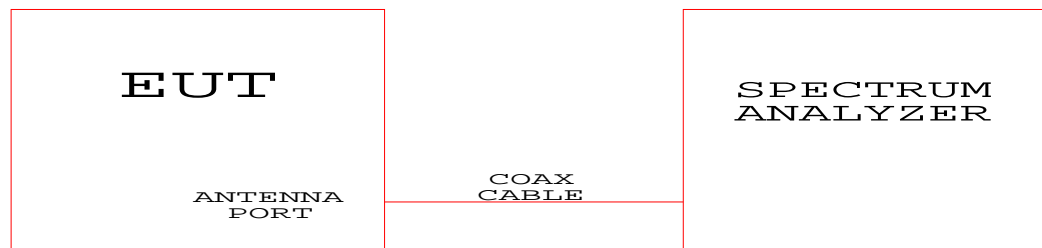
The spectrum analyzer's resolution bandwidth and video bandwidth were set as follows:

RBW = 100 kHz

VBW = 300 kHz

Type of Equipment	Manufacturer	Model Number	Serial Number
Spectrum Analyzer	Hewlett Packard	8566B	2230A01711
Quasi-Peak Detector	Hewlett Packard	85650A	2043A00137
Spectrum Analyzer/Receiver	Rohde & Schwarz	1302.6005.40	100064
Low Loss Cable (1 dB)	N/A	N/A	N/A

An independent calibration laboratory or Nemko-CCL, Inc. personnel calibrates all the equipment listed above at intervals defined in ANSI C63.4:2003 Section 4.4 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to tractability is on file and is available for examination upon request.

Test Configuration Block Diagram

A1.3 §15.247(b)(3) Peak Output Power

The EUT was directly connected to the spectrum analyzer via the antenna output port as shown in the block diagram below.

The measurements were performed on three channels, as per 47 CFR 15.31(m), one near the bottom of the spectrum, one near the middle of the spectrum and one near the top of the spectrum.

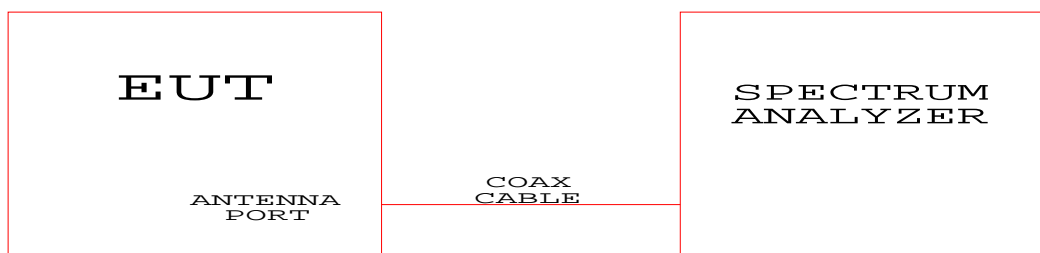
The spectrum analyzer's resolution bandwidth and video bandwidth were set as follows:

RBW = 1 MHz

VBW = 10 MHz

Type of Equipment	Manufacturer	Model Number	Serial Number
Spectrum Analyzer/Receiver	Rohde & Schwarz	1302.6005.40	100064
Low Loss Cable (1 dB)	N/A	N/A	N/A

An independent calibration laboratory or Nemko-CCL, Inc. personnel calibrates all the equipment listed above at intervals defined in ANSI C63.4:2003 Section 4.4 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to tractability is on file and is available for examination upon request.

Test Configuration Block Diagram

A1.4 §15.247(c) Conducted Spurious Emissions

The EUT was directly connected to the spectrum analyzer via the antenna output port as shown in the block diagram below.

The measurements were performed on three channels, as per 47 CFR 15.31(m), one near the bottom of the spectrum, one near the middle of the spectrum and one near the top of the spectrum.

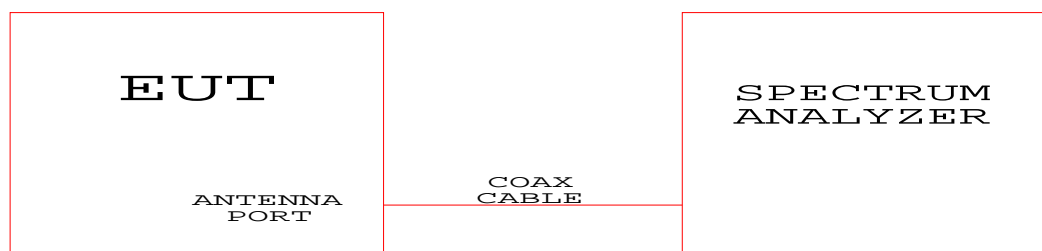
The spectrum analyzer's resolution bandwidth and video bandwidth were set as follows:

RBW = 100 kHz

VBW = 300 kHz

Type of Equipment	Manufacturer	Model Number	Serial Number
Spectrum Analyzer	Hewlett Packard	8566B	2230A01711
Quasi-Peak Detector	Hewlett Packard	85650A	2043A00137
Spectrum Analyzer/Receiver	Rohde & Schwarz	1302.6005.40	100064
Low Loss Cable (1 dB)	N/A	N/A	N/A

An independent calibration laboratory or Nemko-CCL, Inc. personnel calibrates all the equipment listed above at intervals defined in ANSI C63.4:2003 Section 4.4 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to tractability is on file and is available for examination upon request.

Test Configuration Block Diagram

A1.5 §15.247(c) Radiated Spurious Emissions in the Restricted Bands

The radiated emissions from the intentional radiator were measured using a spectrum analyzer with a quasi-peak adapter for peak and quasi-peak readings. An amplifier and preamplifier were used to increase the sensitivity of the measuring instrumentation. The quasi-peak adapter uses a bandwidth of 120 kHz, with the spectrum analyzer's resolution bandwidth set at 1 MHz, for readings in the 30 to 1000 MHz frequency ranges. For peak emissions above 1000 MHz the spectrum analyzer's resolution bandwidth was set to 1 MHz and the video bandwidth was set to 3 MHz. For average emissions above 1000 MHz the spectrum analyzer's resolution bandwidth was set to 1 MHz and the average detector of the analyzer was used.

A biconilog antenna was used to measure the frequency range of 30 to 1000 MHz and a Double Ridge Guide Horn antenna was used to measure the frequency range of 1 GHz to 18 GHz, and a Pyramidal Horn antenna was used to measure the frequency range of 18 GHz to 25 GHz, at a distance of 3 meters and 1 meter from the EUT. The readings obtained by the antenna are correlated to the levels obtained with a tuned dipole antenna by adding antenna factors.

The configuration of the intentional radiator was varied to find the maximum radiated emission. The intentional radiator was connected to the peripherals listed in Section 2.4 via the interconnecting cables listed in Section 2.5. These interconnecting cables were manipulated manually by a technician to obtain worst case radiated emissions. The intentional radiator was rotated 360 degrees, and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission. Where there are multiple interface ports all of the same type, cables are either placed on all of the ports or cables added to these ports until the emissions do not increase by more than 2 dB.

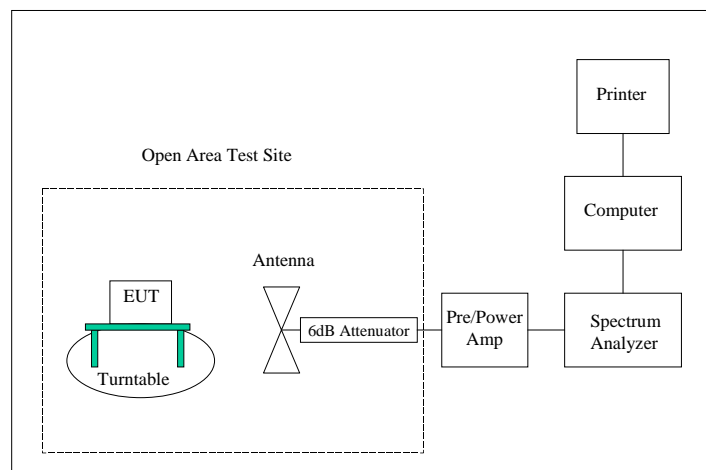
Desktop intentional radiators are measured on a non-conducting table 80 centimeters above the ground plane. The table is placed on a turntable which is level with the ground plane. The turntable has slip rings, which supply AC power to the intentional radiator. For equipment normally placed on floors, the equipment shall be placed directly on the turntable.

Type of Equipment	Manufacturer	Model Number	Serial Number	Date of Last Calibration
Wanship Open Area Test Site #2	Nemko-CCL, Inc.	N/A	N/A	11/16/2011
Test Software	Nemko-CCL, Inc.	Radiated Emissions	Revision 1.3	N/A
Spectrum Analyzer/Receiver	Rohde & Schwarz	1302.6005.40	100064	07/28/2011
Spectrum Analyzer	Hewlett Packard	8566B	2230A01711	01/17/2012
Quasi-Peak Detector	Hewlett Packard	85650A	2043A00137	01/18/2012

Type of Equipment	Manufacturer	Model Number	Serial Number	Date of Last Calibration
Biconilog Antenna	EMCO	3142	9601-1008	10/15/2010
Double Ridged Guide Antenna	EMCO	3115	9604-4779	03/10/2011
2.4 GHz Filter	Microtronics	HPM50111-03	001	06/22/2011
High Frequency Amplifier	Miteq	AFS4-01001800-43-10P-4	1096455	06/22/2011
6' High Frequency Cable	Microcoax	UFB197C-0-0720-000000	1296	05/10/2011
20' High Frequency Cable	Microcoax	UFB197C-1-3120-000000	1297	05/10//2011
3 Meter Radiated Emissions Cable Wanship Site #2	Microcoax	UFB205A-0-4700-000000	1295	05/10/2011
Pre/Power-Amplifier	Hewlett Packard	8447F	3113A05161	08/25/2011
6 dB Attenuator	Hewlett Packard	8491A	32835	12/14/2011

An independent calibration laboratory or Nemko-CCL, Inc. personnel calibrates all the equipment listed above at intervals defined in ANSI C63.4:2003 Section 4.4 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to tractability is on file and is available for examination upon request.

Radiated Emissions Test Setup



A1.6 §15.247(d) Peak Power Spectral Density

The EUT was directly connected to the spectrum analyzer via the antenna output port as shown in the block diagram below.

The measurements were performed on three channels, as per 47 CFR 15.31(m), one near the bottom of the spectrum, one near the middle of the spectrum and one near the top of the spectrum.

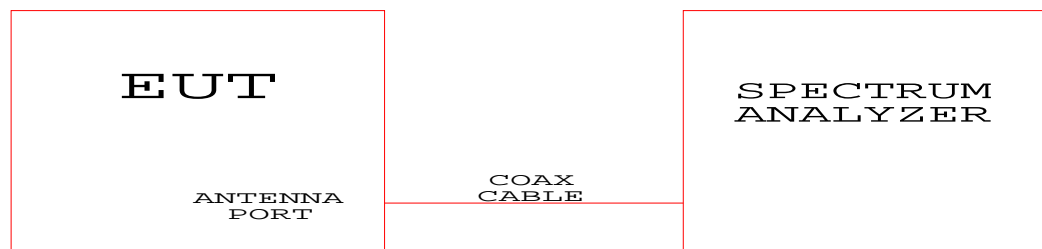
The spectrum analyzer's resolution bandwidth and video bandwidth were set as follows:

RBW = 3 kHz

VBW = 10 kHz

Type of Equipment	Manufacturer	Model Number	Serial Number
Spectrum Analyzer	Hewlett Packard	8566B	2230A01711
Quasi-Peak Detector	Hewlett Packard	85650A	2043A00137
Spectrum Analyzer/Receiver	Rohde & Schwarz	1302.6005.40	100064
Low Loss Cable (1 dB)	N/A	N/A	N/A

An independent calibration laboratory or Nemko-CCL, Inc. personnel calibrates all the equipment listed above at intervals defined in ANSI C63.4:2003 Section 4.4 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to tractability is on file and is available for examination upon request.

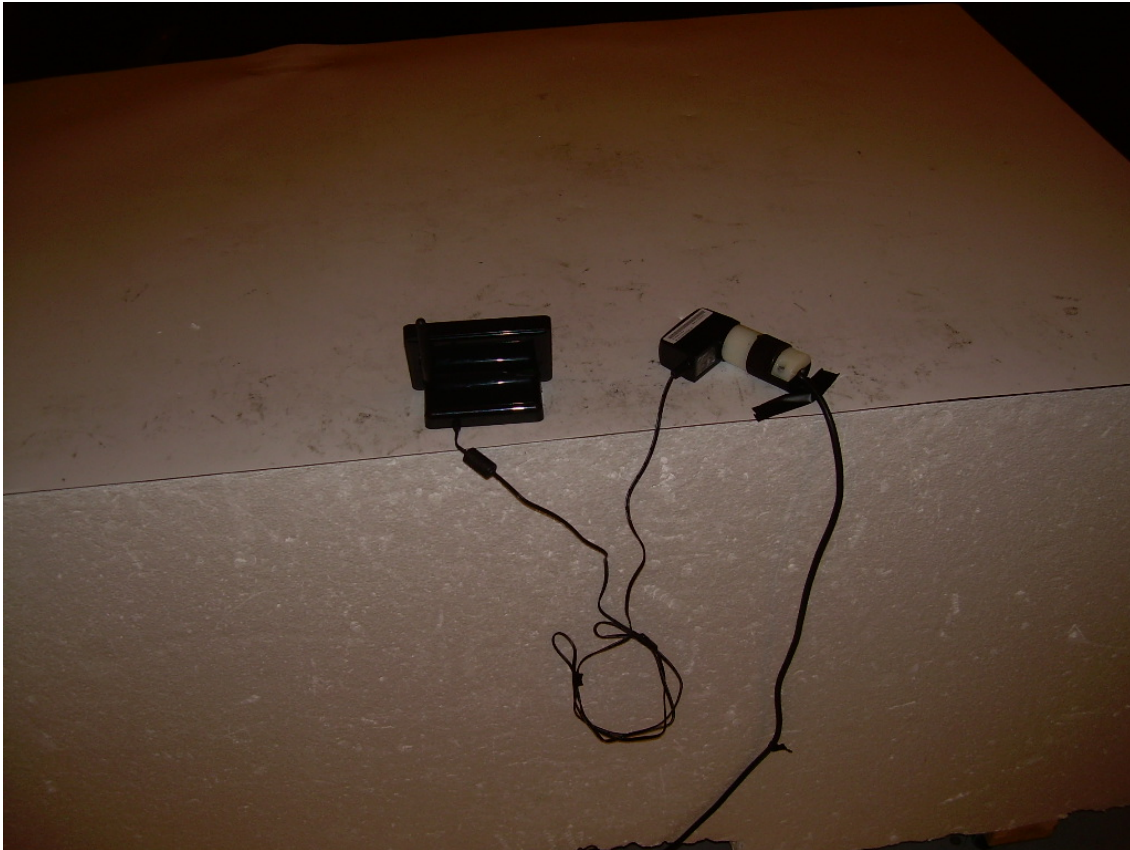
Test Configuration Block Diagram

APPENDIX 2 PHOTOGRAPHS

Photograph 1 – Front View Radiated Disturbance Worst Case Configuration



Photograph 2 – Back View Radiated Disturbance Worst Case Configuration



Photograph 3 – Front View Conducted Disturbance Worst Case Configuration



Photograph 4 – Back View Conducted Disturbance Worst Case Configuration



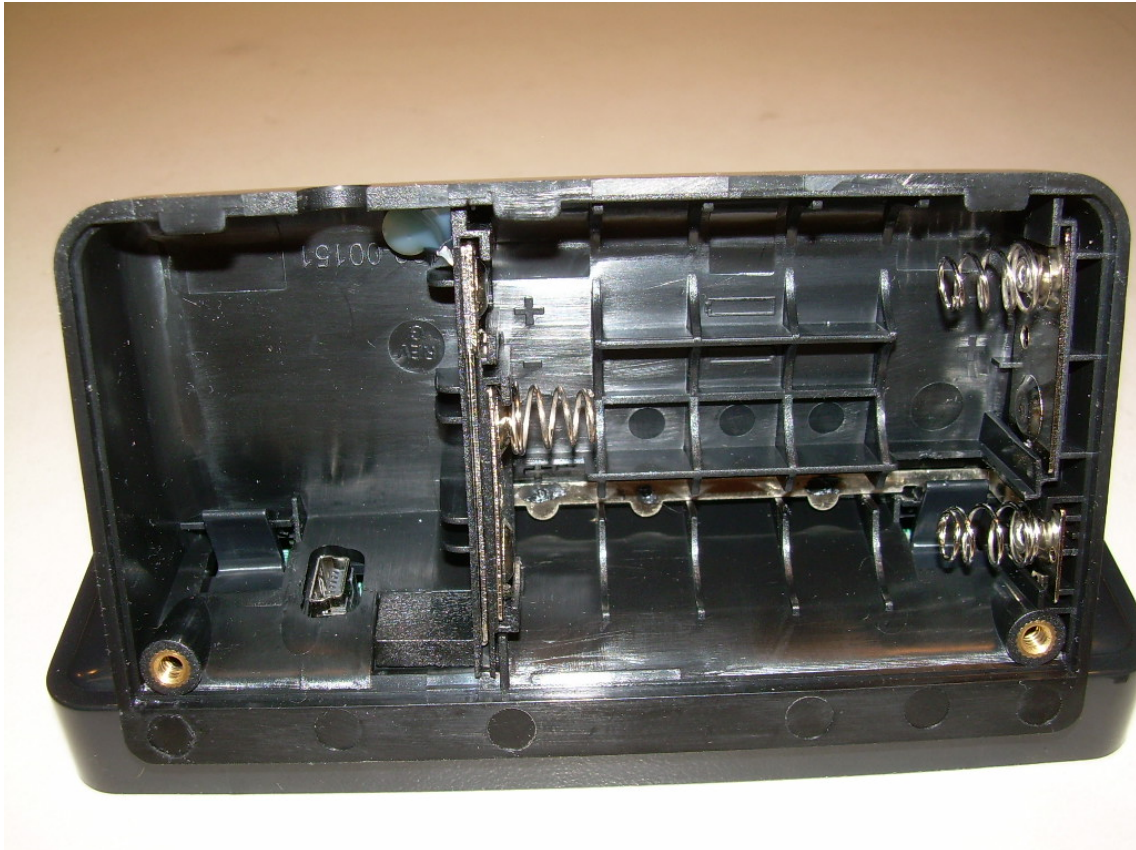
Photograph 5 – Front View of the EUT



Photograph 6 – Back View of the EUT



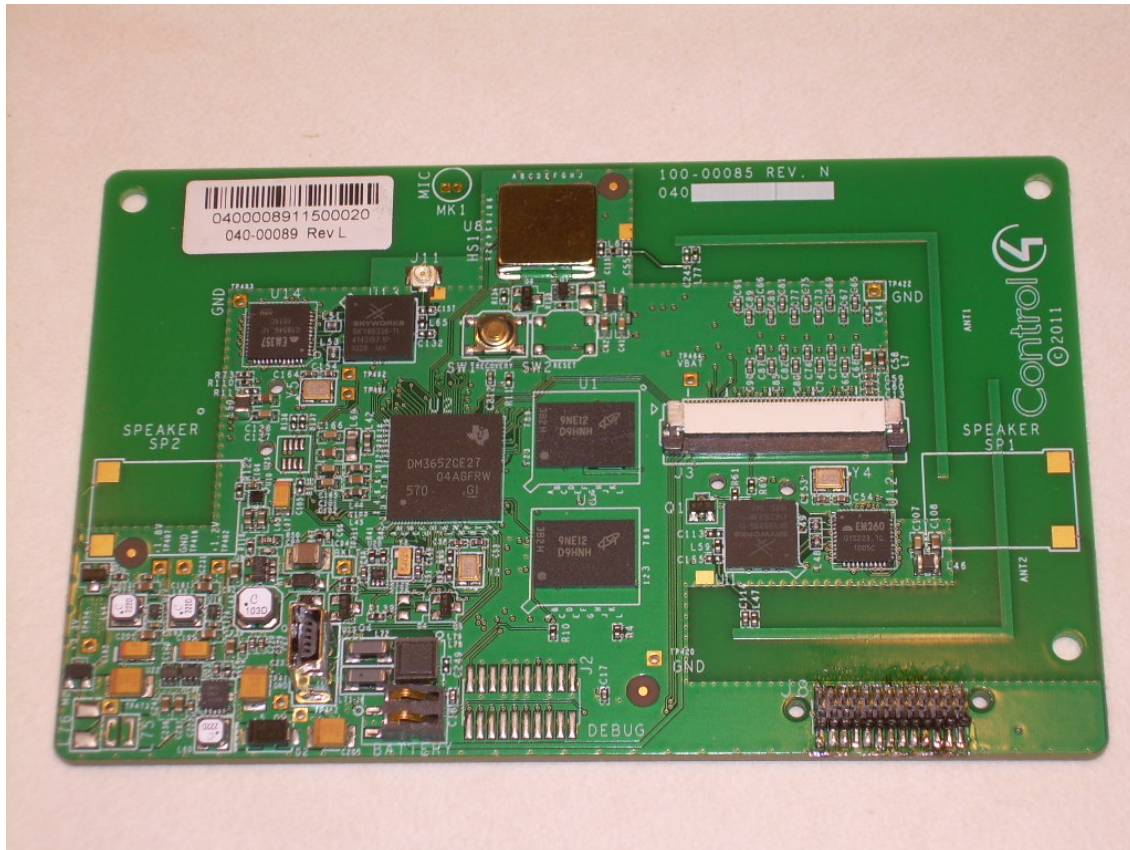
Photograph 7 – View of the EUT with the Bottom/Battery Cover Removed



Photograph 8 – View of the Back of the Touch Screen Assembly



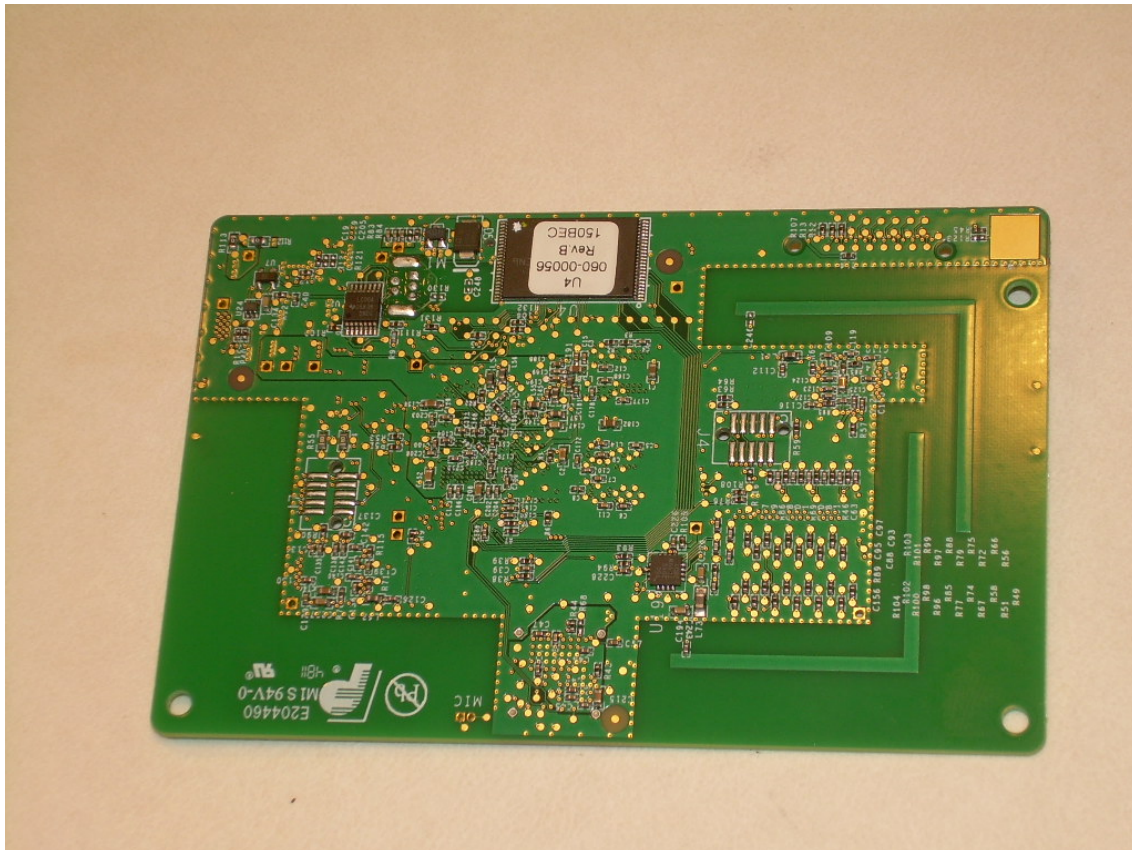
Photograph 9 – View of the Front Side of the PCB



Photograph 10 – View of the Circuitry Under the RF Shield



Photograph 11 – View of the Back Side of the PCB



Photograph 12 – View of the Sparkle FSP010-DWDA1 Power Supply



Photograph 17 – View of the FranMar DSC6PFA-05 Power Supply



APPENDIX 3 MANUFACTURER'S STATEMENT/ATTESTATION

The manufacturer or responsible party for the equipment tested hereby affirms:

- a) That he/she has reviewed and concurs that the tests shown in this report are reflective of the operational characteristics of the device for which certification is sought;
- b) That the device in this test report will be representative of production units;
- c) That the product will have all of the documented modifications incorporated into the product when manufactured and placed on the market;
- d) That all changes in hardware and software/firmware to the subject device will be reviewed.
- e) That any changes impacting the attributes, functionality or operational characteristics documented in this report will be communicated to the body responsible for approving or certifying the subject equipment.

Printed name of official

Signature of official

Date

NOTE—This affirmation must be signed by the responsible party before it is submitted to a regulatory body for approval.

APPENDIX 4 TRANSMITTER DUTY CYCLE CALCULATIONS**IEEE 802.15.4-2003 2.4 GHz PHY Constants**

Data Rate	250000	bits / sec	
	31250	bytes / sec	
Symbols/byte	2	sym / bytes	
Symbol Timing	62500	sym / sec	
	0.000016	sec / sym	
Byte Timing	0.000032	sec / byte	
PHY PSDU	6	bytes	4 Preamble, SPD, Length
Max Length	127	bytes	
Total Packet Length	133	bytes	
Maximum Time TX PKT	0.004256	sec	

Long Frame Scenario:

- 1) TX Frame Assume Frame is Data Frame
- 2) Wait for ACK
- 3) RX ACK
- 4) CPU Processing of ACK
- 5) Wait for Backoff
- 6) Repeat 1)

MAC-Level Calculation (LIFS)

Long InterFrame Spacing (Slotted w/ ACK)			
Long Frame	127	bytes	
Data Frame Payload	102	bytes	
ACK Frame	5	bytes	
tack	12	sym	
LIFS	40	sym	
Backoff Period	20	sym	
Maximum Backoff	31		Random between 0 and 31
Backoff Required	2		
Backoff Time	300	sym	Average at 15
Transmit Time			
TX Time (Packet)	0.004256		
Total TX Time (sec)	0.004256		
NOT Transmit time (RX or Idle)			
Wait for ACK (tack)	0.000192		
RX Time (ACK)	0.000352		
Backoff Time (tbo)	0.0048		
CPU Processing (tcpu)	0.0002		
CCA Assessment (tcca)	0.000128		
Turn Around Time (RX to TX)	0.000192		
Total Off Time (sec)	0.005864		
Total Time (ttotal)	0.01012	(0.004256 + 0.005864)	MAC TX Duty Cycle (On/Total) = 42.06