Nemko-CCL, Inc.

1940 West Alexander Street
Salt Lake City, UT 84119
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Test Report

Type of Report:
Certification

Test Of:
C4-HC250-BL and SCH-CONTROL-250

FCC ID: R33C4HC250

Test Specifications:
FCC PART 15, Subpart C

Test Report Serial No: 190371-3.2

Applicant:

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

Dates of Test: March 26, 28, & 29, 2012

Report Issue Date: April 30, 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-HC250-BL

- Brand Name: CISCO
- Model Number: SCH-CONTROL-250

- FCC ID Number: R33C4HC250

On this 30th day of April 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.

Norman P Hansen

Tested by: Norman P. Hansen
Test Technician

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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-HC250-BL
Serial Number: F83

2.2 Description of EUT:

The C4-HC250-BL is a controller for a home automation system. Typical applications include automating home theater, multi-room music, lighting, temperature, and security. The C4-HC250-BL uses an 802.15.4 Zigbee transceiver and an 802.11bgn transceiver to interface home networks. Other interfaces include IR Out, Ethernet, USB, component video, HDMI, left and right audio, and analog line level audio in. The EUT may be powered by the AC mains or by Power-Over-Ethernet.

This report also covers the CISCO SCH-CONTROL-250. The SCH-CONTROL-250 is identical to the C4-HC250-BL except in branding and labeling.

The C4-HC250-BL 802.11b/g/n transceiver uses 11 channels in the 2400 to 2483.5 MHz frequency range. The antenna is an inverted F trace antenna on the PCB. See the table of channels 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 802.11b, 802.11g, and 802.11n.

The C4-HC250-BL Zigbee transceivers use 15 channels in the 2400 to 2483.5 MHz frequency range. The antenna for 802.15.4 Zigbee Radio is an inverted F antenna on the PCB. A discreet component filter is incorporated on the amplifier output. Testing was performed at the upper, middle, and lowest channel. 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	20
802.11b	1 – 11	+12	N/A
802.11g	1 - 11	+11	N/A
802.11n	1 - 11	+9	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 #190371-2.1.

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-HC250-BL (Note 1) SN: F83	R33C4HC250	Home Automation Controller	See Section 2.4

Brand Name Model Number Serial Number	FCC ID Number or Compliance	Description	Name of Interface Ports / Interface Cables
BN: Samsung MN: LN19D250G1D SN: None	DoC	Television	HDMI/HDMI cable with ferrites (Note 2) Component Video/Component Video cable with RCA connectors (Note 2) Audio/Audio cables with RCA connectors (Note 2)
BN: Cisco MN: SD208P SN: DNI154410QG	DoC	POE Switch	Ethernet/Cat 5e cable Ethernet with Power/Cat 5e cable (Note 2)
BN: Dell MN: Latitude SN: None	DoC	Computer	Ethernet/Cat 5e cable

Note: (1) EUT
(2) Interface port connected to EUT (See Section 2.4)

The support equipment listed above was not modified in order to achieve compliance with this standard.

2.4 Interface Ports on EUT:

Name of Ports	No. of Ports Fitted to EUT	Cable Descriptions/Length
Ethernet/POE	1	Cat 5e cable/1.5 or 7 meters
Audio In	1	Cable with 3.5 mm Stereo jack/1 meter
Audio Out	1	Cable with 3.5 mm Stereo jack and RCA connectors/1 meter
HDMI	1	HDMI cable with Steward 28A2025-0A2 ferrites at each end/1.3 meters

Name of Ports	No. of Ports Fitted to EUT	Cable Descriptions/Length
Component Video (Y, Pb, Pr)	1	Cable with RCA connectors/1.5 meters
USB	1	USB cable/1 meter
IR Out	4	IR emitters with 2 unshielded conductors to 3.5 mm mono jack/1.5 meters
Relay	1	3 unshielded conductors to Phoenix Contact connector/1 meter
Contact	1	3 unshielded conductors to Phoenix Contact connector/1 meter
AC In	1	3 conductor NEMA cable/1.2 meters

2.5 Modification Incorporated/Special Accessories on EUT:

The following modifications were made to the EUT by the Client during testing to comply with the specification. This report is not complete without an accompanying signed attestation that the product will have all of the documented modifications incorporated into the product when manufactured and placed on the market.

1. A Steward 28A2025-0A2 ferrite was added to the Ethernet cable at the EUT.
2. A Steward 28A2025-0A2 ferrite was added at each end of the HDMI cable.

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 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the 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 stave 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: 2003 and KDB 558074 D01 DTS Measurement Guidance v01. 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 February 15, 2012 (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, or 48 VDC using POE

4.2 Operating Modes:

The 802.11b/g/n transmitter was tested while in a constant transmit mode at the upper, middle, and lower channels. 802.11b, 802.11g, and 802.11n modes were tested. Data rates were at 1 mbps for spurious emissions and at 1 mb for all other testing in 802.11b mode. The data rate was at 6 mbps for all 802.11g testing. The data rate was at 6.5 mbps for all 802.11n testing. The 802.15.4 transceiver was tested at the upper, middle, and lower channels. 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-HC250-BL 802.11b/g/n transceiver and 802.15.4 transceiver 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	0.15 – 25000	Complied
15.247(c)	Radiated Spurious Emissions	0.15 – 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/n 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 an inverted F 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)
0.18	Hot Lead	Quasi-Peak (Note 2)	58.4	64.5	-6.1
0.18	Hot Lead	Average (Note 2)	48.5	54.5	-6.0
0.20	Hot Lead	Quasi-Peak (Note 2)	53.6	63.5	-9.9
0.20	Hot Lead	Average (Note 2)	43.0	53.5	-10.5
0.27	Hot Lead	Quasi-Peak (Note 2)	52.3	61.2	-8.9
0.27	Hot Lead	Average (Note 2)	41.2	51.2	-10.0
0.35	Hot Lead	Quasi-Peak (Note 2)	45.6	58.9	-13.3
0.35	Hot Lead	Average (Note 2)	34.0	48.9	-14.9
0.44	Hot Lead	Quasi-Peak (Note 2)	44.5	57.0	-12.5
0.44	Hot Lead	Average (Note 2)	35.0	47.0	-12.0
0.52	Hot Lead	Quasi-Peak (Note 2)	43.5	56.0	-12.5
0.52	Hot Lead	Average (Note 2)	33.6	46.0	-12.4
0.18	Neutral Lead	Quasi-Peak (Note 2)	59.1	64.5	-5.4

Frequency (MHz)	AC Mains Lead	Detector	Measured Level (dBµV)	Limit (dBµV)	Margin (dB)
0.18	Neutral Lead	Average (Note 2)	47.0	54.5	-7.5
0.20	Neutral Lead	Quasi-Peak (Note 2)	56.6	63.6	-7.0
0.20	Neutral Lead	Average (Note 2)	42.2	53.6	-11.4
0.27	Neutral Lead	Quasi-Peak (Note 2)	52.9	61.2	-8.3
0.27	Neutral Lead	Average (Note 2)	37.7	51.2	-13.5
0.31	Neutral Lead	Quasi-Peak (Note 2)	48.3	60.0	-11.7
0.31	Neutral Lead	Average (Note 2)	35.7	50.0	-14.3
0.34	Neutral Lead	Quasi-Peak (Note 2)	45.4	59.2	-13.8
0.34	Neutral Lead	Average (Note 2)	32.6	49.2	-16.6
0.40	Neutral Lead	Quasi-Peak (Note 2)	44.0	57.8	-13.8
0.40	Neutral Lead	Average (Note 2)	32.4	47.8	-15.4
Note 2: 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 5.4 dB.

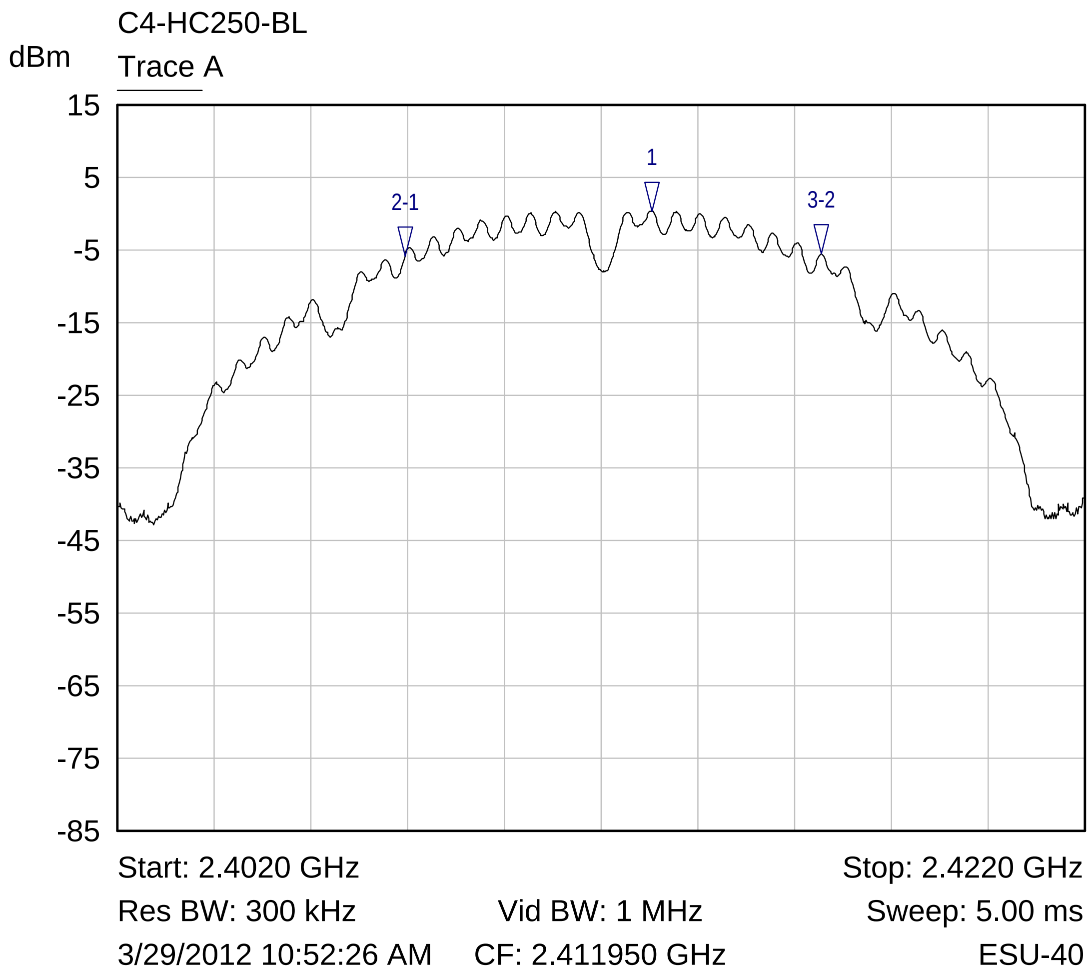
6.2.3 §15.247(a)(2) Emission Bandwidth

Frequency (MHz)	802.11b Emission 6 dB bandwidth (MHz)	802.11g Emission 6 dB bandwidth (MHz)	802.11n Emission 6 dB bandwidth (MHz)
2412	8.62	16.20	17.48
2437	8.22	16.12	17.38
2462	8.24	16.16	17.38

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).

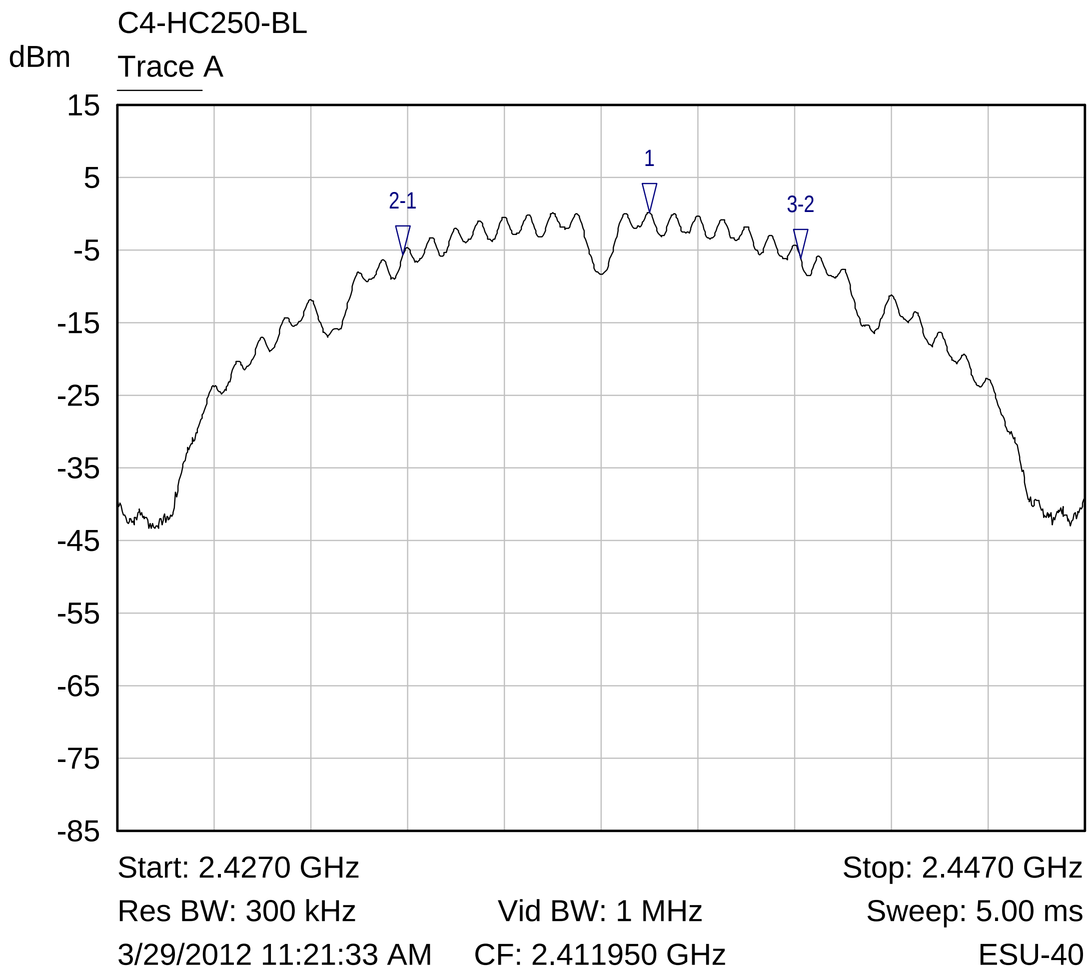
Lowest Channel 802.11b Emission 6 dB Bandwidth



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4130 GHz	0.42 dBm	
2-1 ▽	Trace A	-5.1000 MHz	-6.19 dB	
3-2 ▽	Trace A	8.6200 MHz	0.21 dB	

Trace A bandwidth 802.11b +12

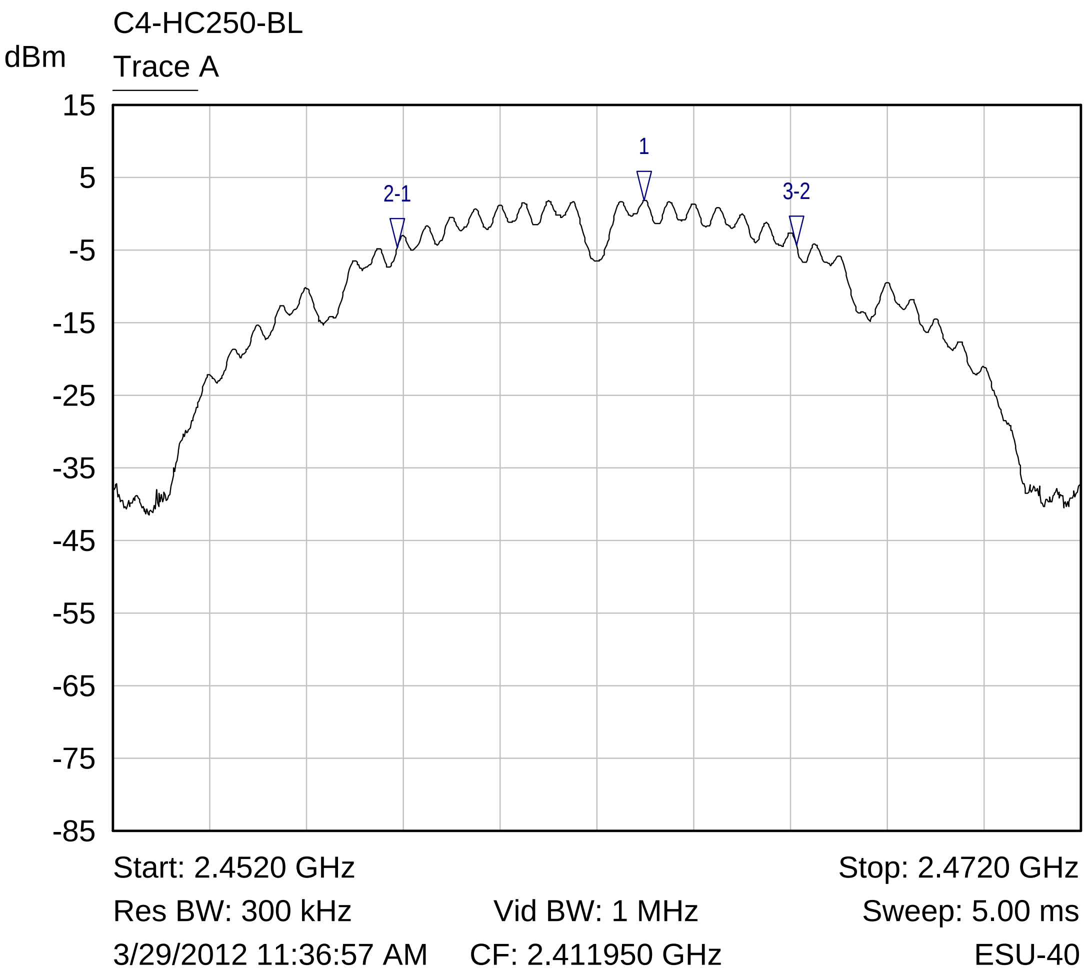
Middle Channel 802.11b Emission 6 dB Bandwidth



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4380 GHz	0.22 dBm	
2-1 ▽	Trace A	-5.1000 MHz	-5.91 dB	
3-2 ▽	Trace A	8.2200 MHz	-0.50 dB	

Trace A band width 802.11b +12

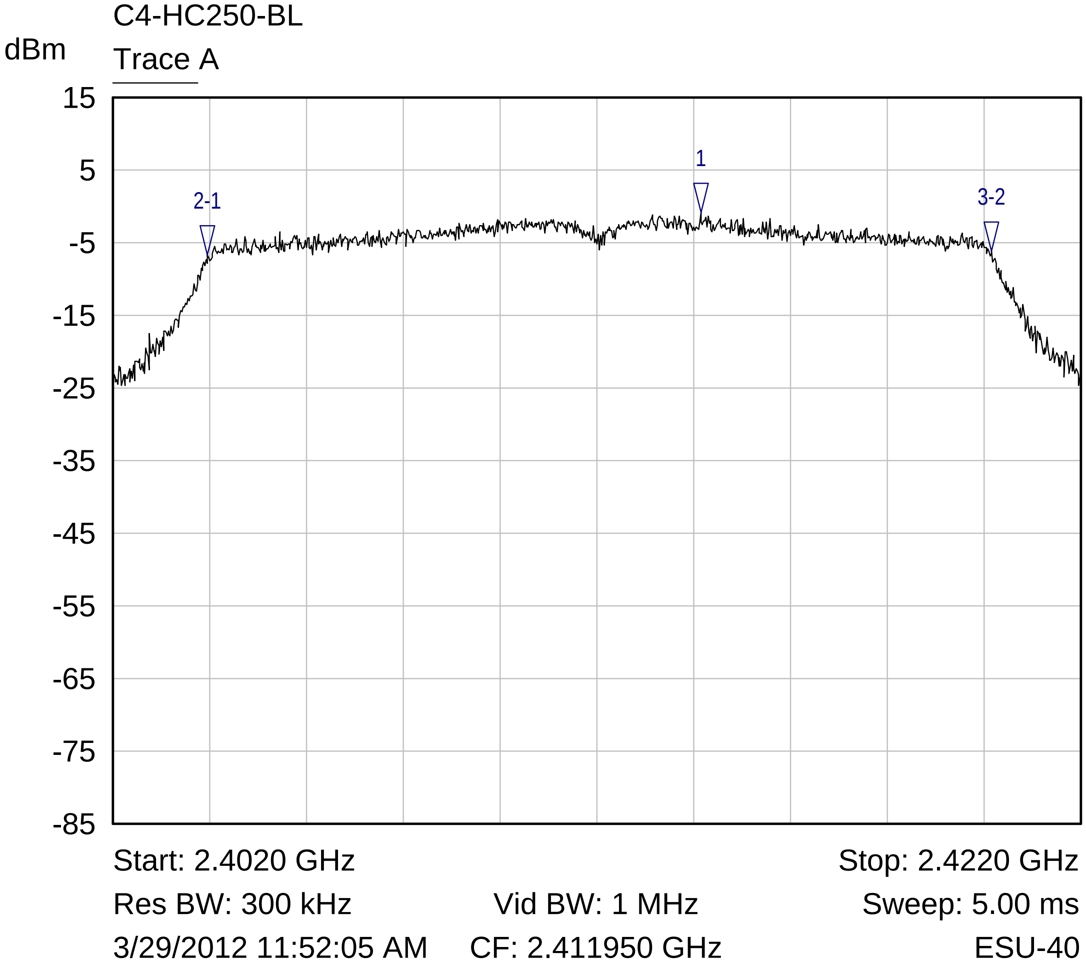
Highest Channel 802.11b Emission 6 dB Bandwidth



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4630 GHz	1.85 dBm	
2-1 ▽	Trace A	-5.1000 MHz	-6.45 dB	
3-2 ▽	Trace A	8.2400 MHz	0.31 dB	

Trace A bw 802.11b +12

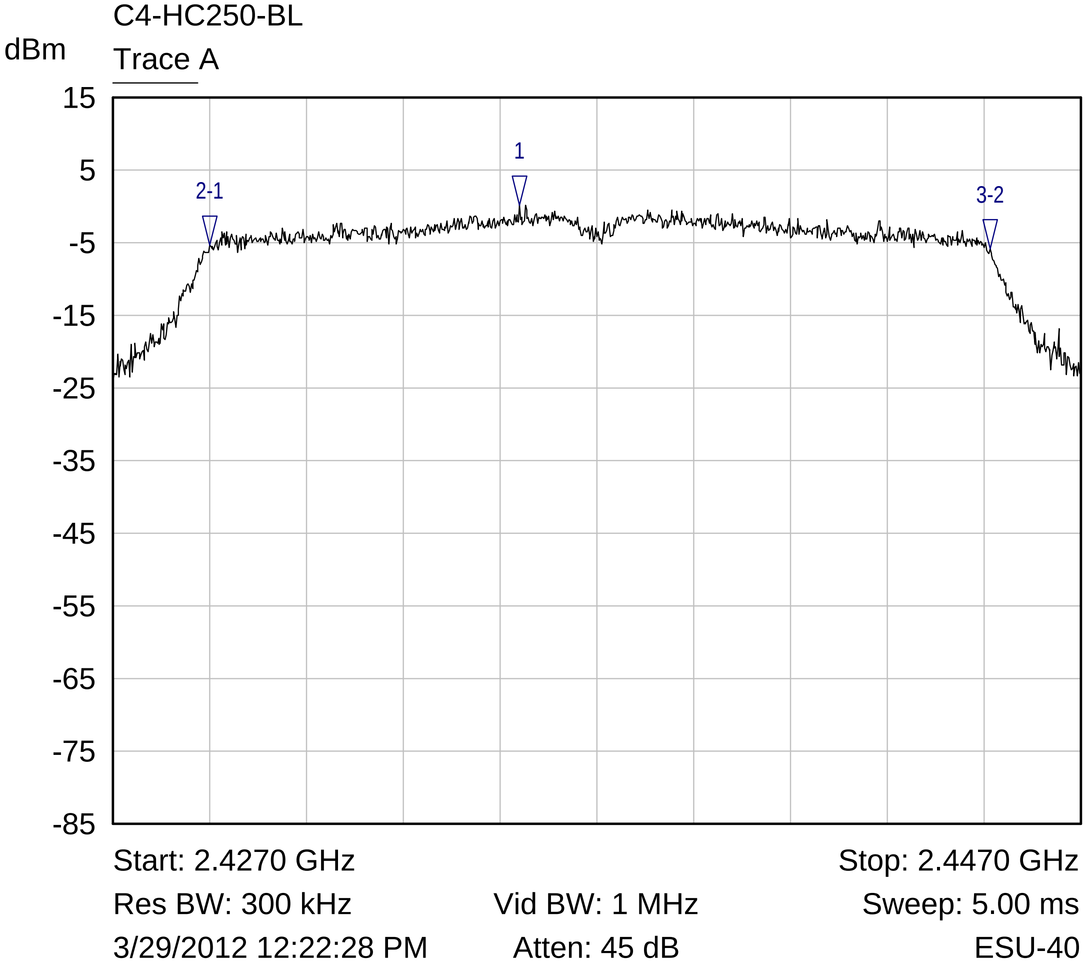
Lowest Channel 802.11g Emission 6 dB Bandwidth



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4141 GHz	-0.85 dBm	
2-1 ▽	Trace A	-10.1800 MHz	-5.87 dB	
3-2 ▽	Trace A	16.2000 MHz	0.54 dB	

Trace A bandwidth 802.11g +11

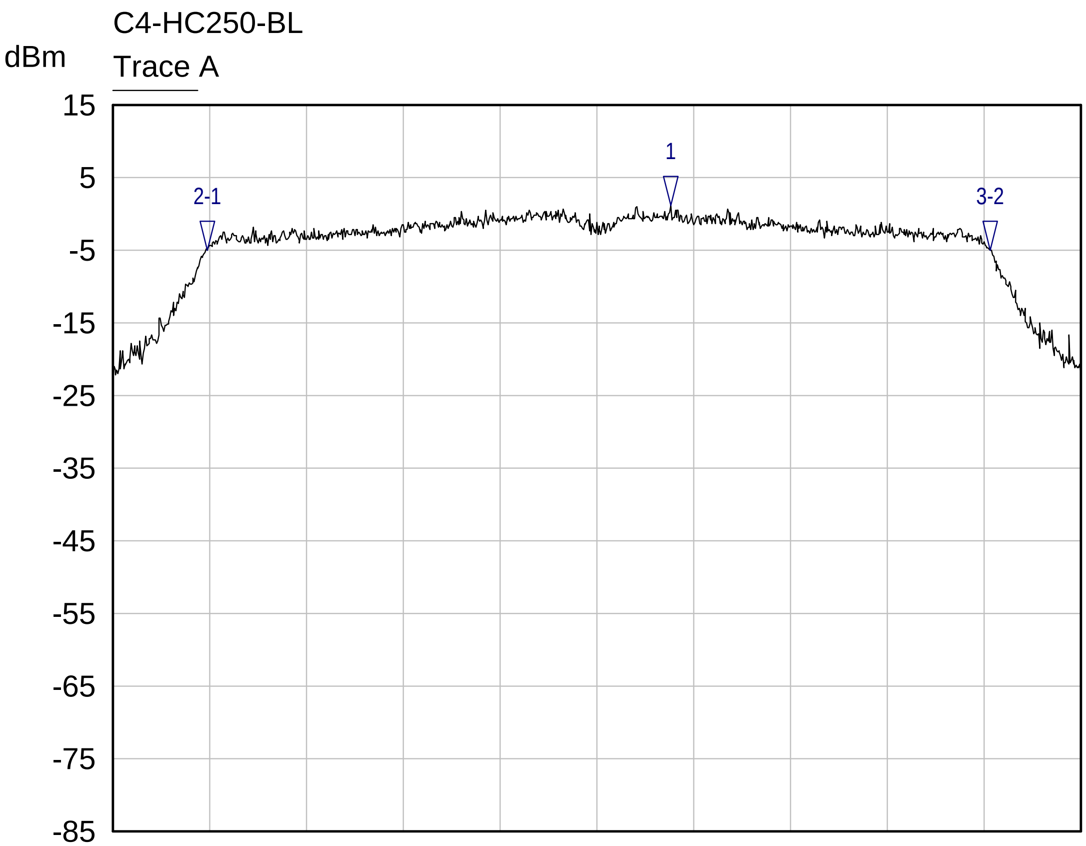
Middle Channel 802.11g Emission 6 dB Bandwidth



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4354 GHz	0.23 dBm	
2-1 ▽	Trace A	-6.4000 MHz	-5.61 dB	
3-2 ▽	Trace A	16.1200 MHz	-0.47 dB	

Trace A Bandwidth 802.11g +11

Highest Channel 802.11g Emission 6 dB Bandwidth

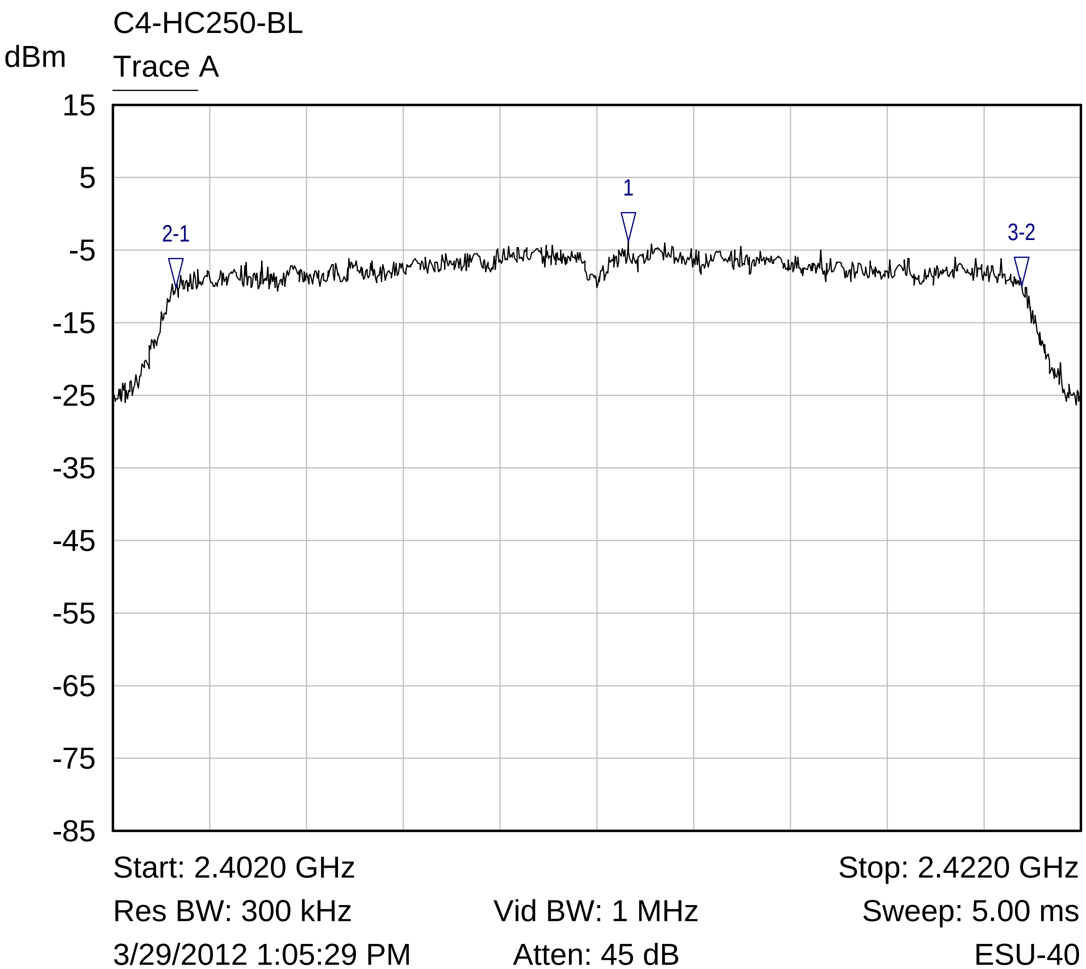


Start: 2.4520 GHz | Stop: 2.4720 GHz
Res BW: 300 kHz | Vid BW: 1 MHz | Sweep: 5.00 ms
3/29/2012 12:48:57 PM | Atten: 45 dB | ESU-40

Mkr	Trace	X-Axis	Value	Notes
1 ∇	Trace A	2.4635 GHz	1.10 dBm	
2-1 ∇	Trace A	-9.5600 MHz	-6.10 dB	
3-2 ∇	Trace A	16.1600 MHz	-0.03 dB	

Trace A bandwidth 802.11g +11

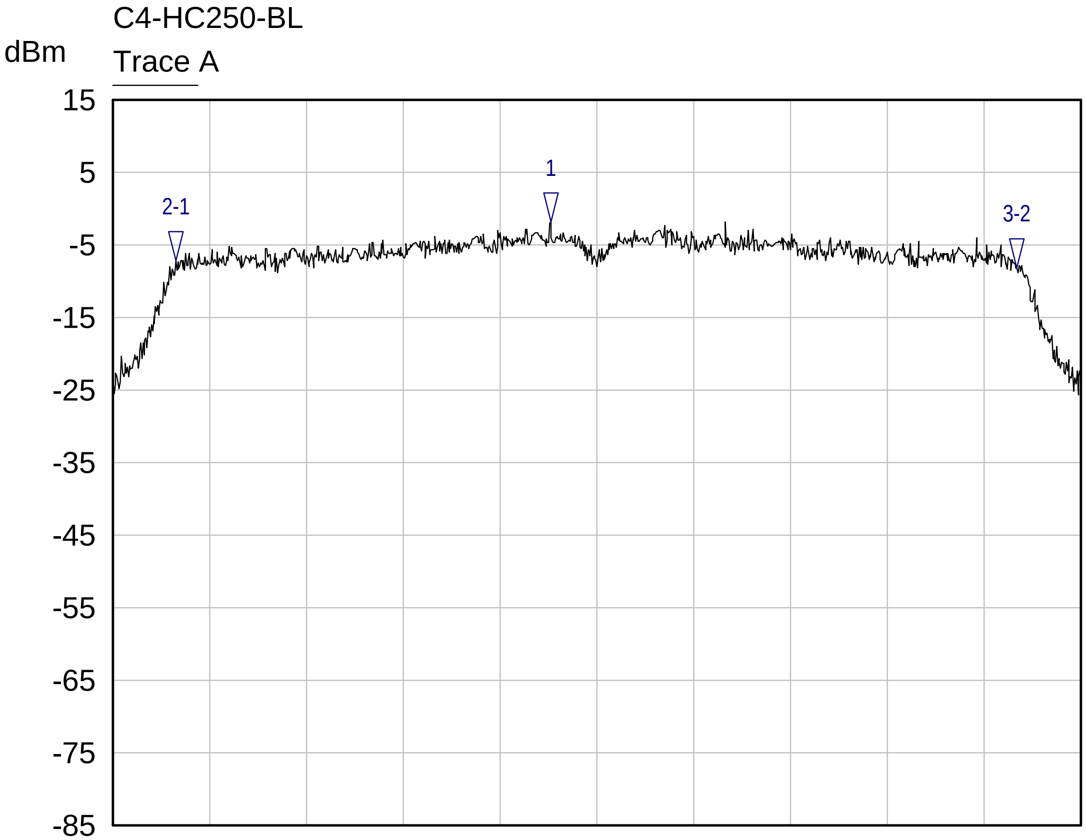
Lowest Channel 802.11n Emission 6 dB Bandwidth



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4126 GHz	-3.79 dBm	
2-1 ▽	Trace A	-9.3400 MHz	-6.33 dB	
3-2 ▽	Trace A	17.4800 MHz	0.15 dB	

Trace A   band width 802.11n +9

Middle Channel 802.11n Emission 6 dB Bandwidth

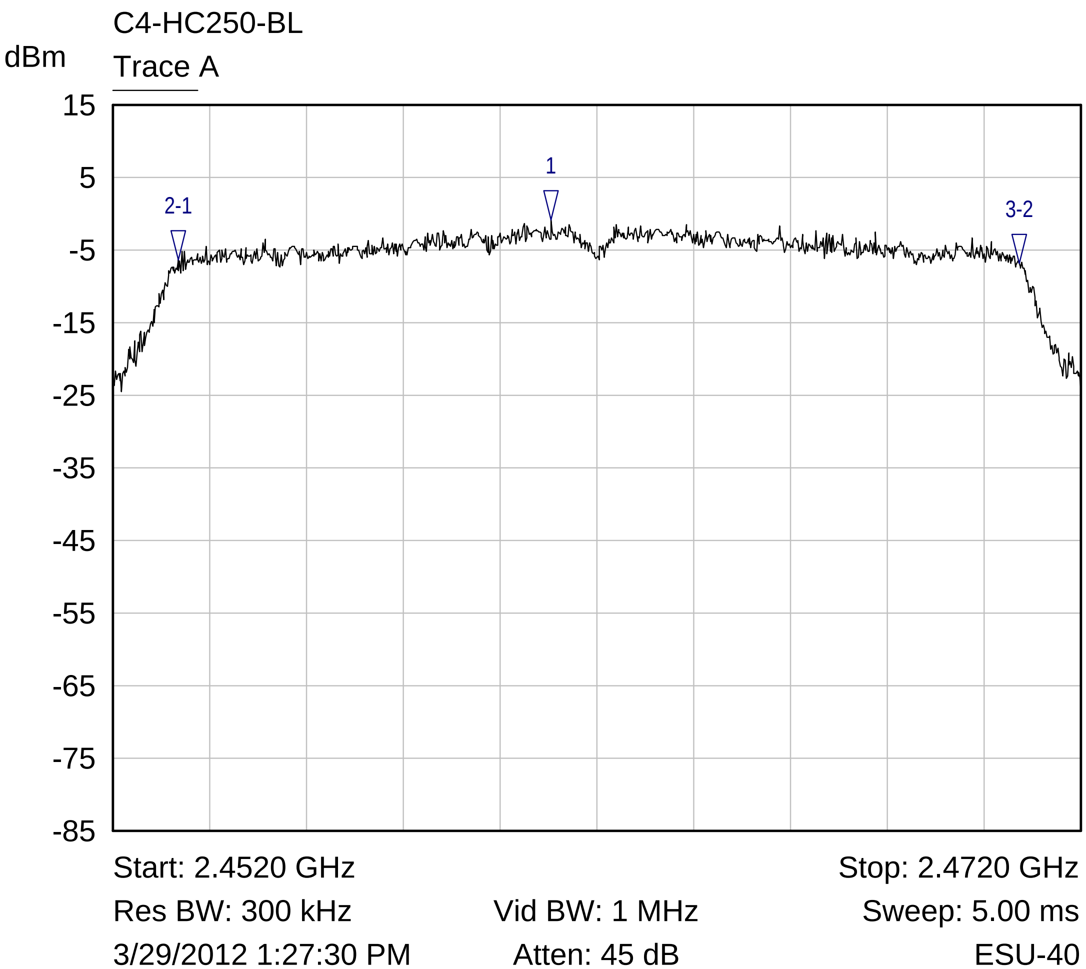


Start: 2.4270 GHz | Stop: 2.4470 GHz
Res BW: 300 kHz | Vid BW: 1 MHz | Sweep: 5.00 ms
3/29/2012 1:39:43 PM | Atten: 45 dB | ESU-40

Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4360 GHz	-1.78 dBm	
2-1 ▽	Trace A	-7.7400 MHz	-5.37 dB	
3-2 ▽	Trace A	17.3800 MHz	-0.99 dB	

Trace A   band width 802.11n +9

Highest Channel 802.11n Emission 6 dB Bandwidth



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4611 GHz	-0.78 dBm	
2-1 ▽	Trace A	-7.7200 MHz	-5.50 dB	
3-2 ▽	Trace A	17.3800 MHz	-0.55 dB	

Trace A band width 802.11n +9

6.2.4 §15.247(b)(3) Peak Output Power

The maximum peak RF Conducted output power measured for this device was 14.93 dBm or 31.11 mW. The limit is 30 dBm or 1 Watt when using antennas with 6 dBi or less gain. The 802.11b/g/n antenna has a maximum gain of 0.04 dBi.

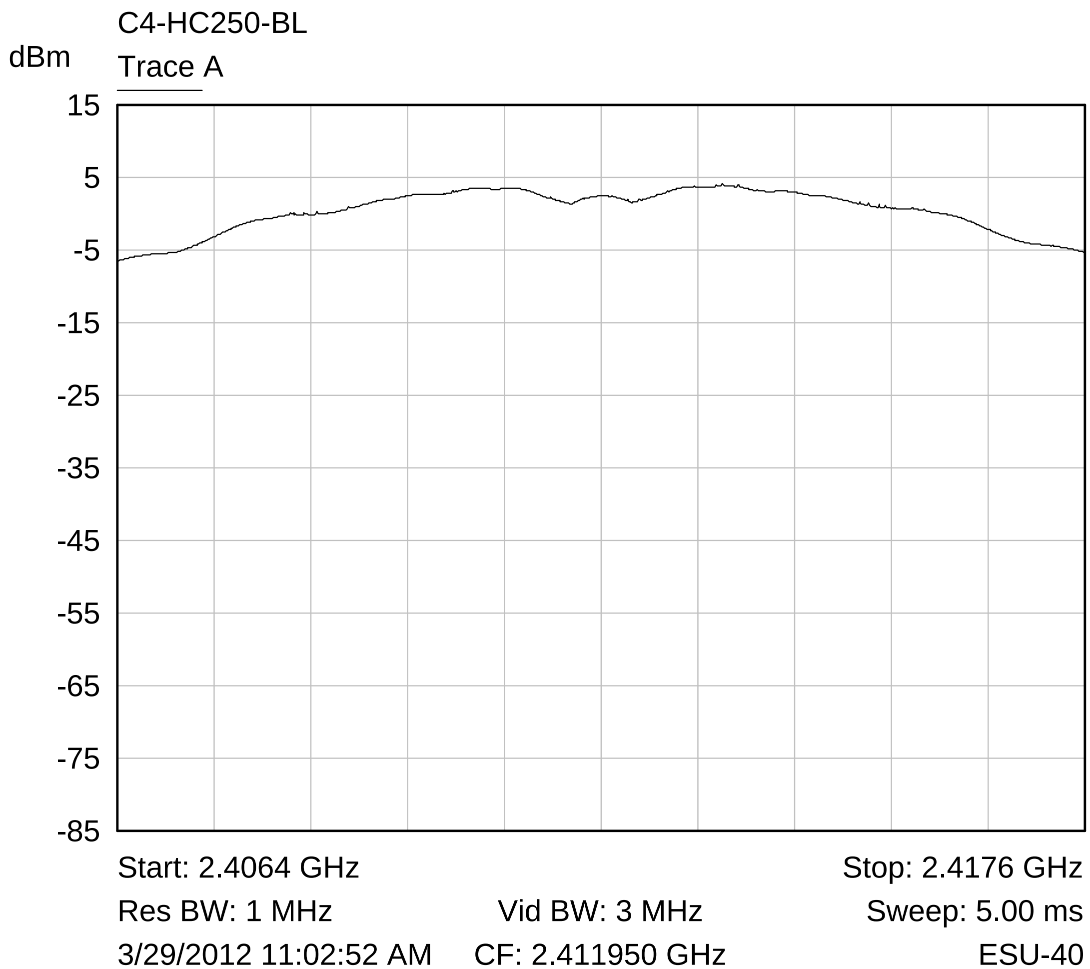
The method described in KDB 558074 D01 DTS Measurement Guidance v01 5.2.1.2 was used to measure and sum the power.

Frequency (MHz)	802.11b Measured Output Power (dBm)	802.11b Measured Output Power (mW)	802.11g Measured Output Power (dBm)	802.11g Measured Output Power (mW)	802.11n Measured Output Power (dBm)	802.11n Measured Output Power (mW)
2412	10.80	12.02	13.77	23.82	11.04	12.71
2437	10.57	11.40	14.20	26.30	12.20	16.60
2462	12.23	16.71	14.93	31.11	12.53	17.91

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).

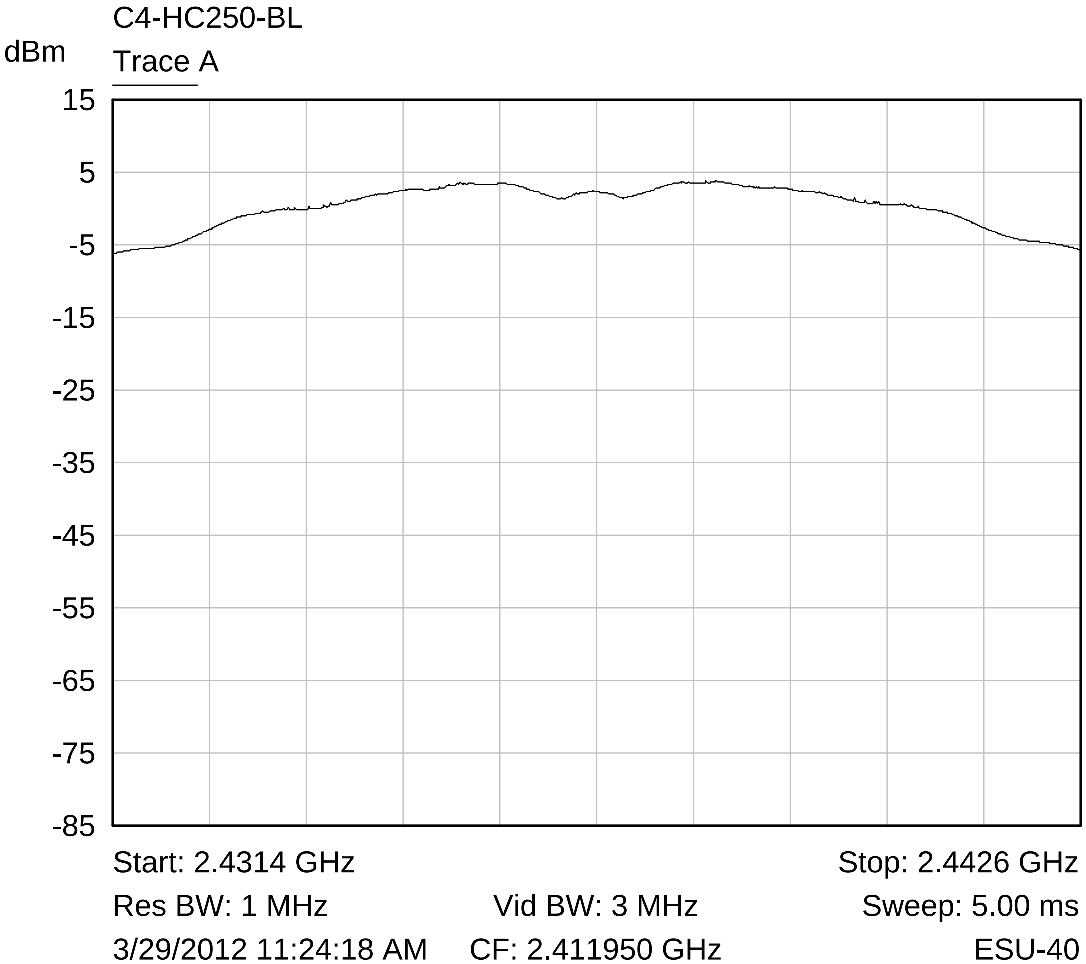
Lowest Channel 802.11b Output Power Plot



Trace A peak output power 802.11b +12

Measurement Parameter	Value
Channel power	10.80 dBm

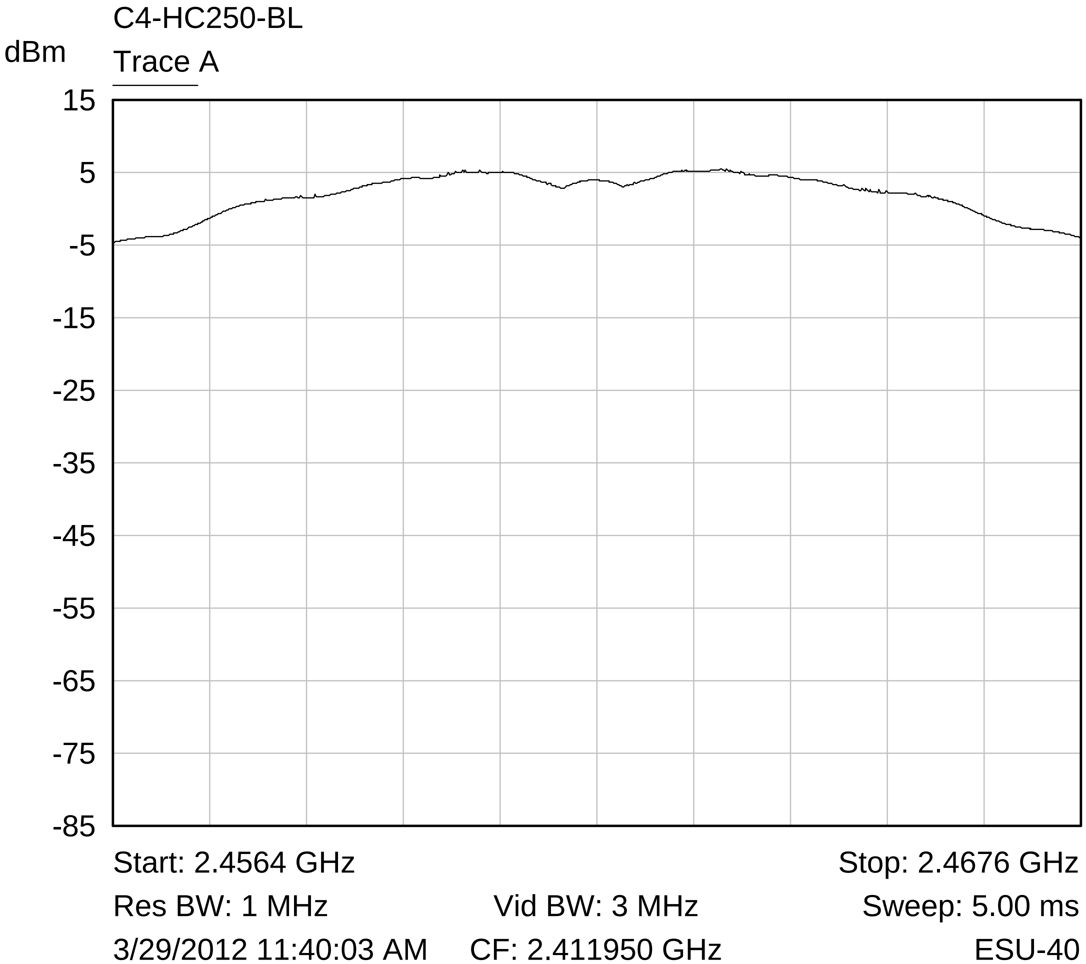
Middle Channel 802.11b Output Power Plot



Trace A peak output power 802.11b +12

Measurement Parameter	Value
Channel power	10.57 dBm

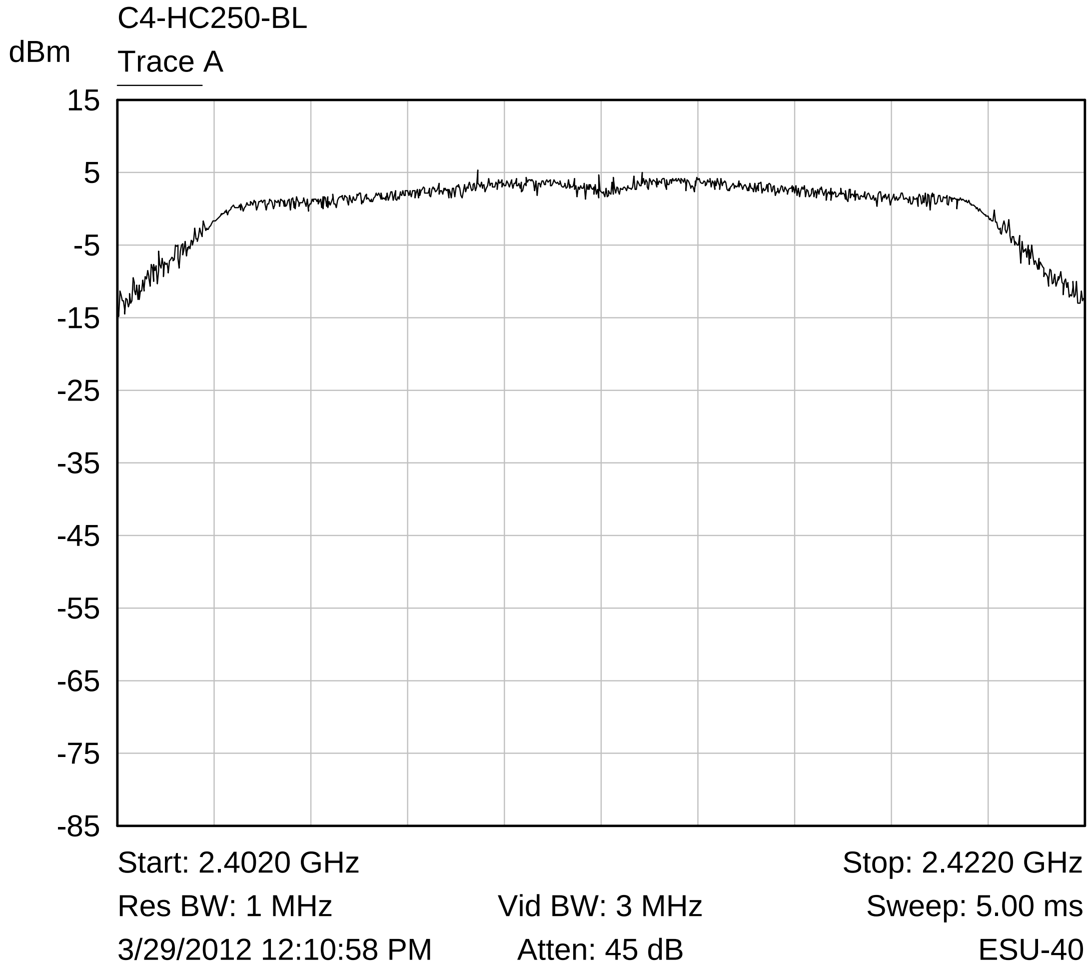
Highest Channel 802.11b Output Power Plot



Trace A peak output power 802.11b +12

Measurement Parameter	Value
Channel power	12.23 dBm

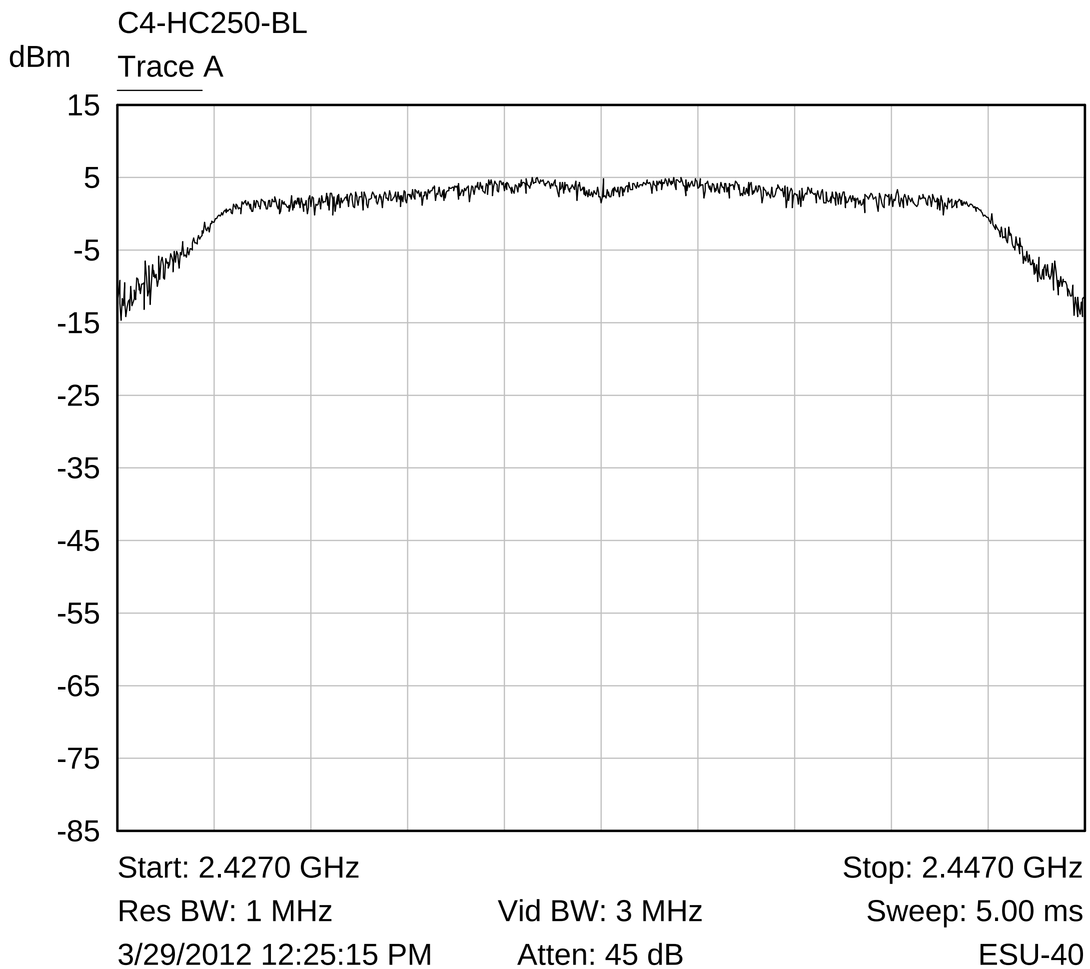
Lowest Channel 802.11g Output Power Plot



Trace A peak power 802.11g +11

Measurement Parameter	Value
Channel power	13.77 dBm

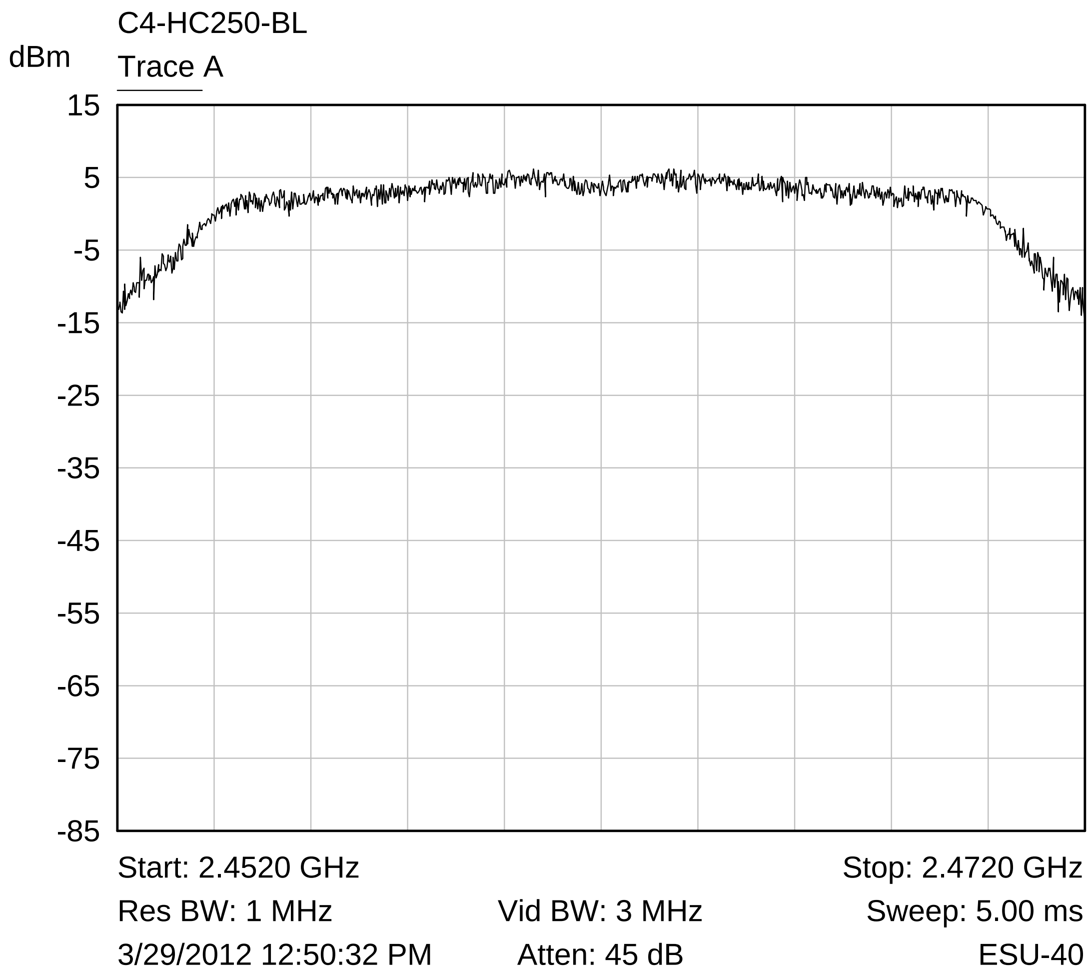
Middle Channel 802.11g Output Power Plot



Trace A Peak output power 802.11g +11

Measurement Parameter	Value
Channel power	14.20 dBm

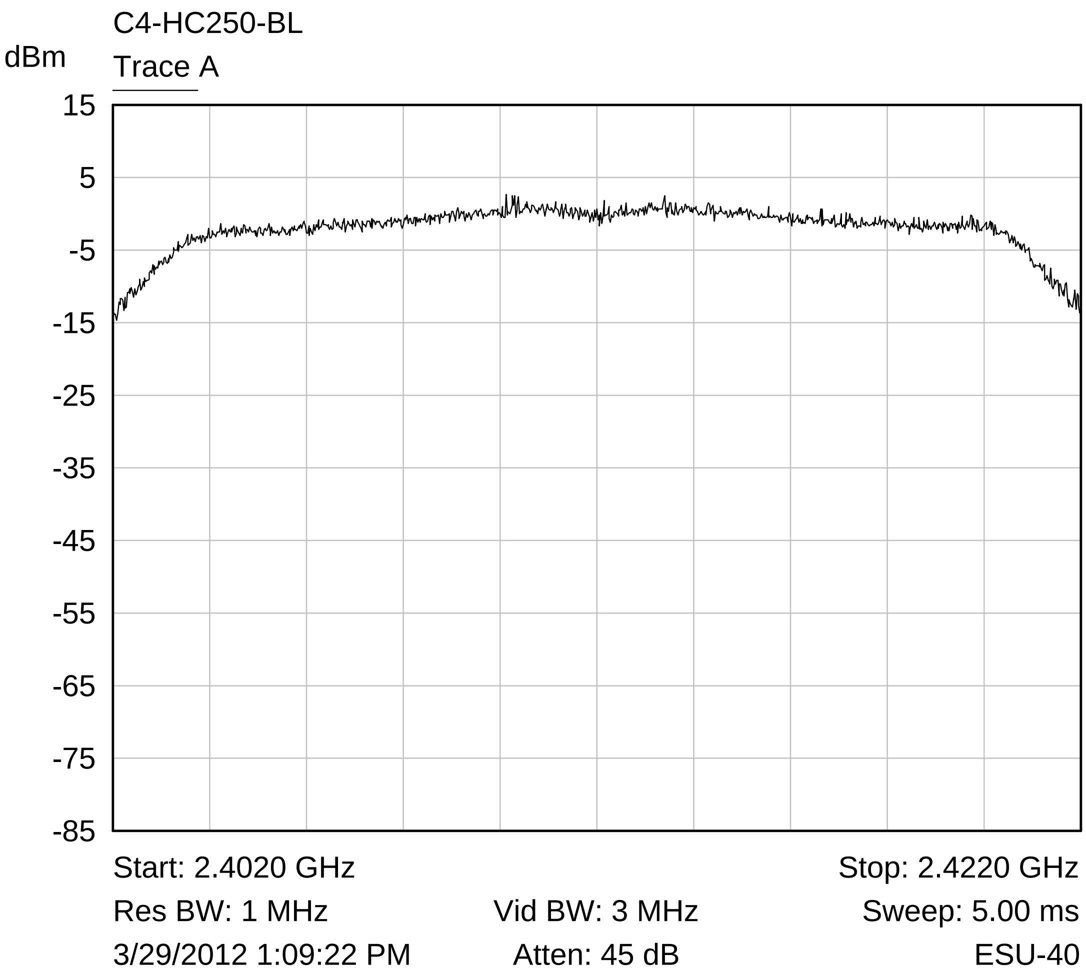
Highest Channel 802.11g Output Power Plot



Trace A output power 802.11g +11

Measurement Parameter	Value
Channel power	14.93 dBm

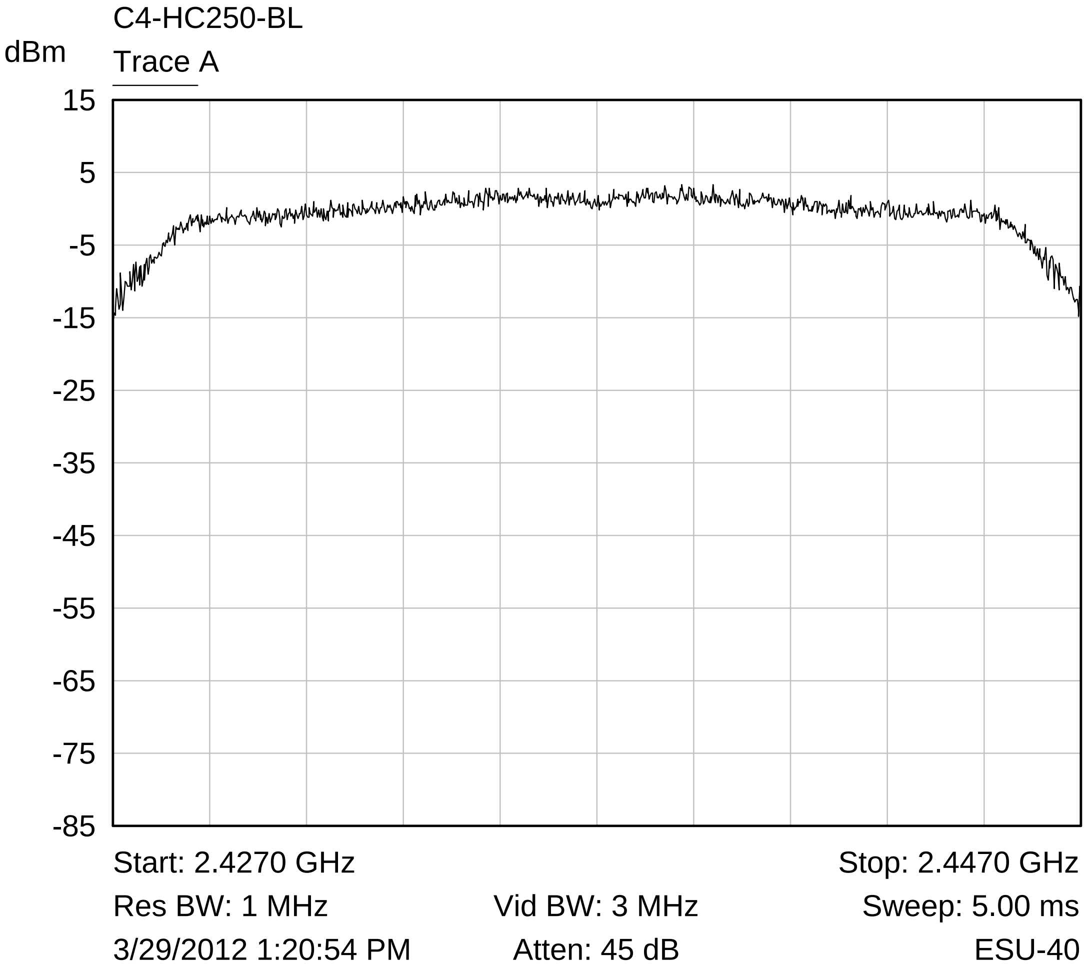
Lowest Channel 802.11n Output Power Plot



Trace A peak output power 802.11n +9

Measurement Parameter	Value
Channel power	11.04 dBm

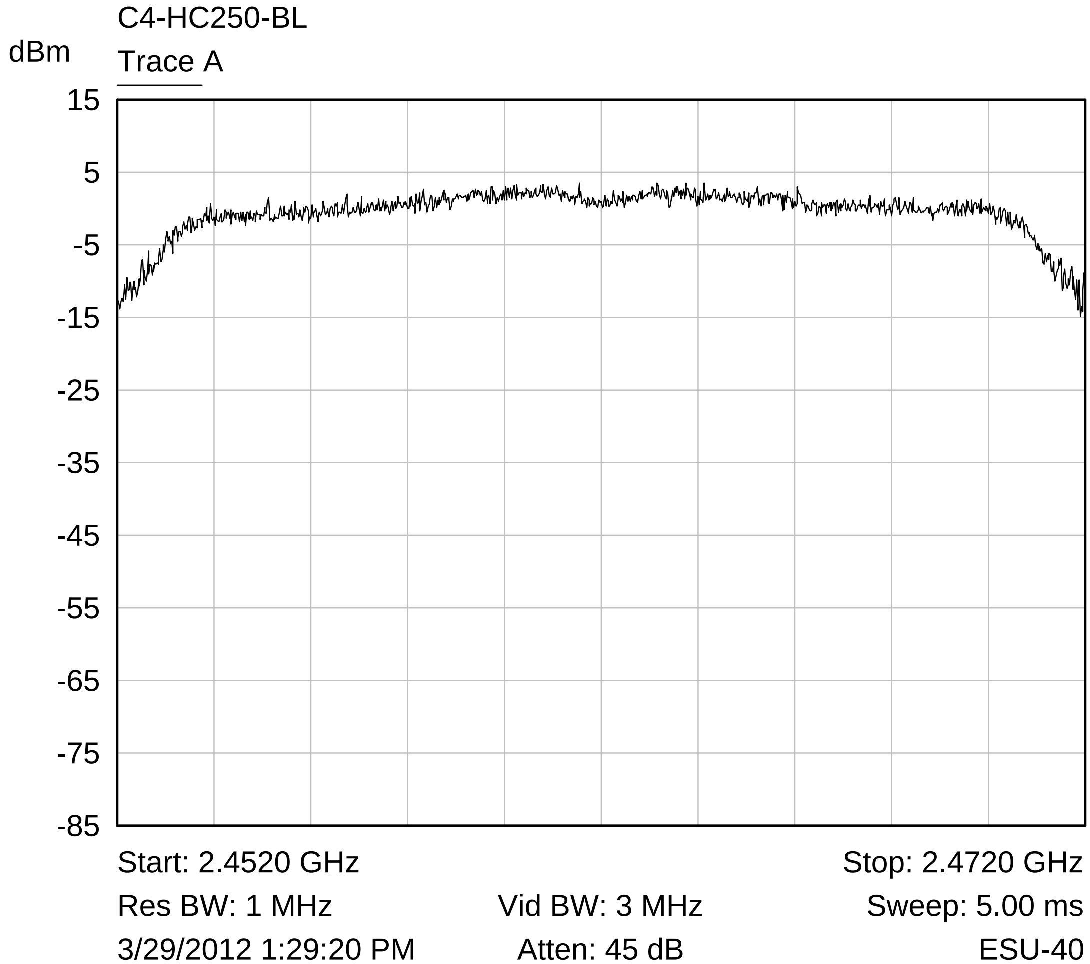
Middle Channel 802.11n Output Power Plot



Trace A peak output power 802.11n +9

Measurement Parameter	Value
Channel power	12.20 dBm

Highest Channel 802.11n Output Power Plot



Trace A peak output power 802.11n +9

Measurement Parameter	Value
Channel power	12.53 dBm

6.2.5 §15.247(c) Spurious Emissions

6.2.5.1 Conducted Spurious Emissions

The frequency range from 150 kHz 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 1.9 dBm; therefore, the criteria is 1.9 – 20.0 = -18.1 dBm. For 802.11g mode, the maximum level was 1.1 dBm; therefore, the criteria is 1.1 – 20 = -18.9 dBm. For 802.11n mode, the maximum level was -0.8 dBm; therefore, the criteria is -0.8 – 20 = -20.8 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	-35.7	-18.1
7236	-48.3	-18.1
9648	-44.8	-18.1
12060	-65.7	-18.1
14472	-66.3	-18.1
16884	-64.7	-18.1
19296	-64.3	-18.1
21708	-64.1	-18.1
24120	-61.5	-18.1

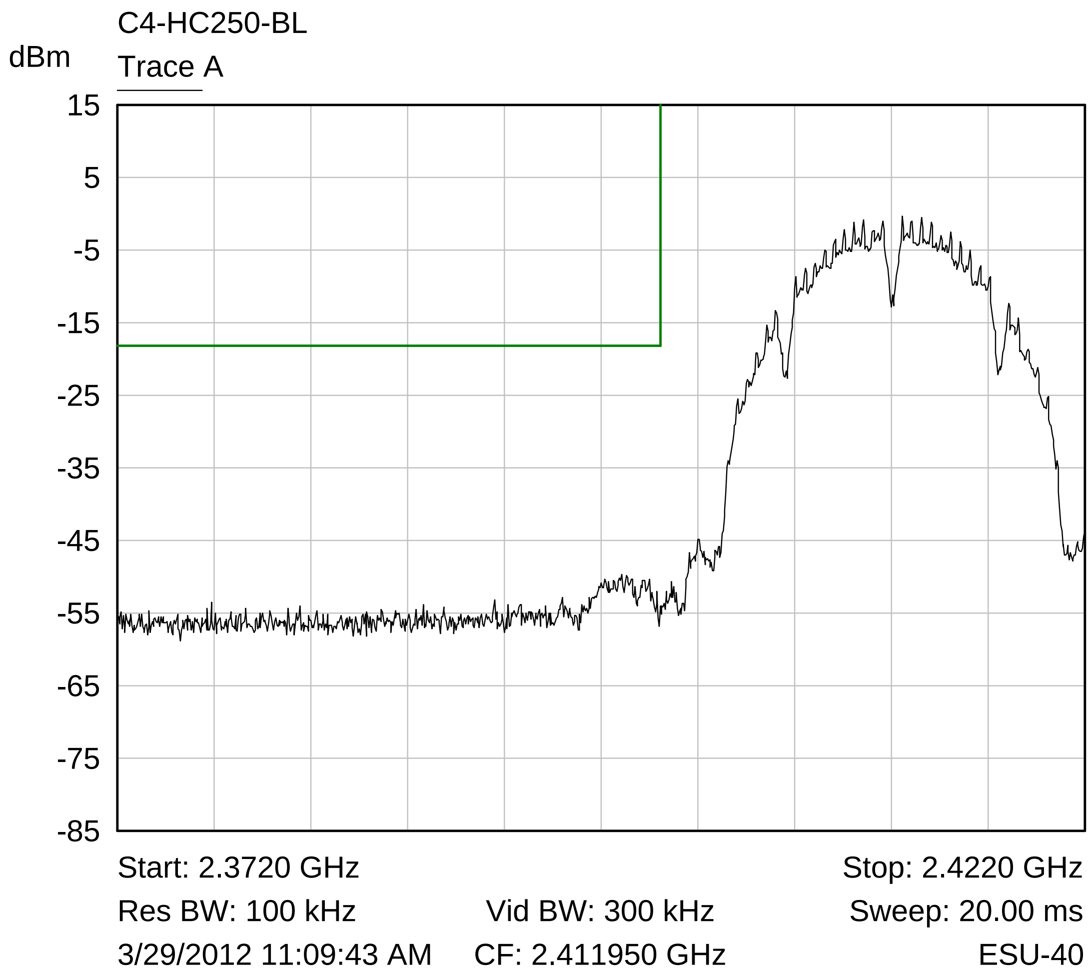
Transmitting on the Middle Channel (2437 MHz) 802.11b

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4874	-54.3	-18.1
7311	-66.4	-18.1
9748	-66.9	-18.1
12185	-65.4	-18.1
14662	-65.2	-18.1
17059	-64.6	-18.1
19496	-64.3	-18.1
21993	-64.2	-18.1
24370	-61.8	-18.1

Transmitting on the Highest Channel (2462 MHz) 802.11b

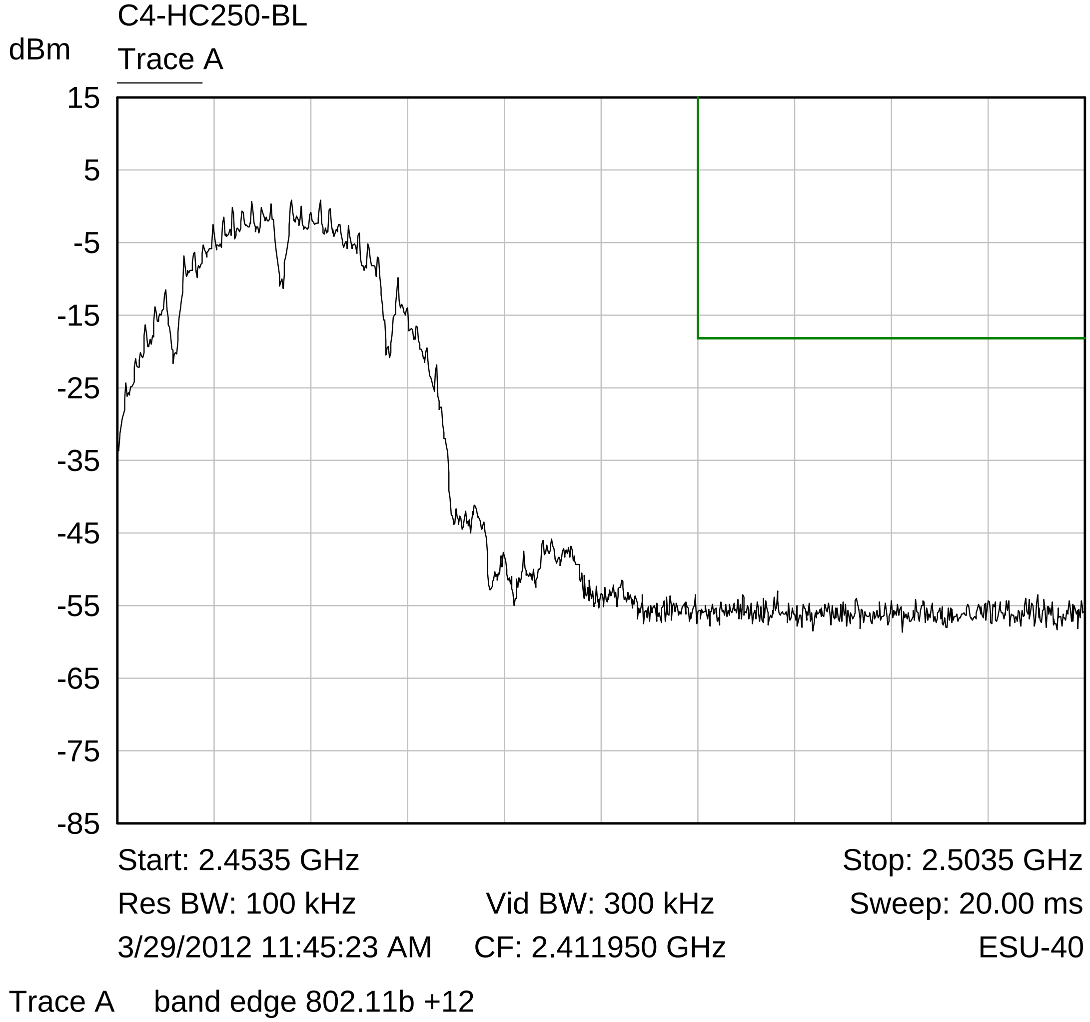
Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4924	-53.7	-18.1
7386	-65.6	-18.1
9848	-67.2	-18.1
12310	-66.2	-18.1
14772	-65.6	-18.1
17234	-65.0	-18.1
19696	-64.3	-18.1
22158	-64.7	-18.1
24620	-62.7	-18.1

Lower Band Edge Plot – 802.11b



Trace A band edge 802.11b +12

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	-64.0	-18.9
7236	-65.9	-18.9
9648	-67.1	-18.9
12060	-65.3	-18.9
14472	-65.8	-18.9
16884	-65.1	-18.9
19296	-65.2	-18.9
21708	-63.2	-18.9
24120	-62.6	-18.9

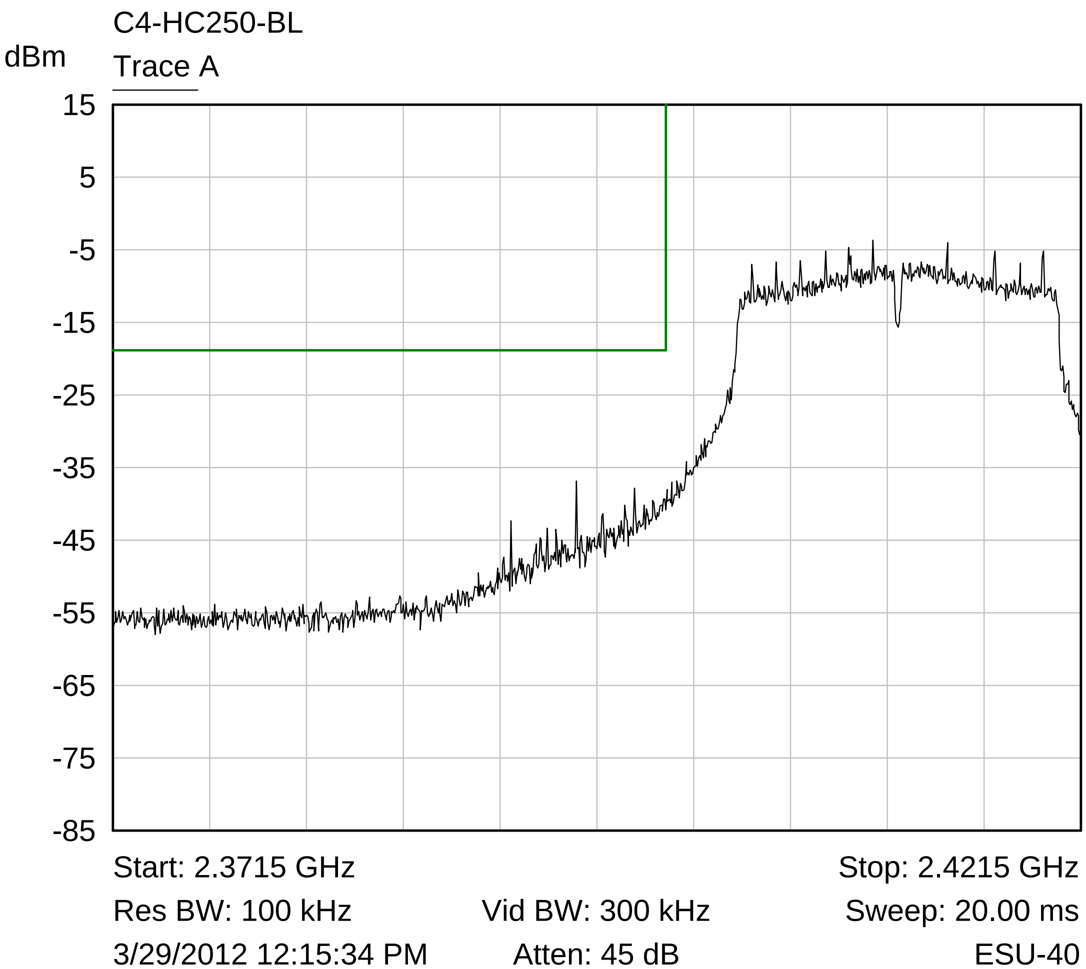
Transmitting on the Middle Channel (2437 MHz) 802.11g

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4874	-64.4	-18.9
7311	-65.8	-18.9
9748	-66.7	-18.9
12185	-66.1	-18.9
14662	-65.8	-18.9
17059	-65.4	-18.9
19496	-64.3	-18.9
21993	-64.2	-18.9
24370	-61.4	-18.9

Transmitting on the Highest Channel (2462 MHz) 802.11g

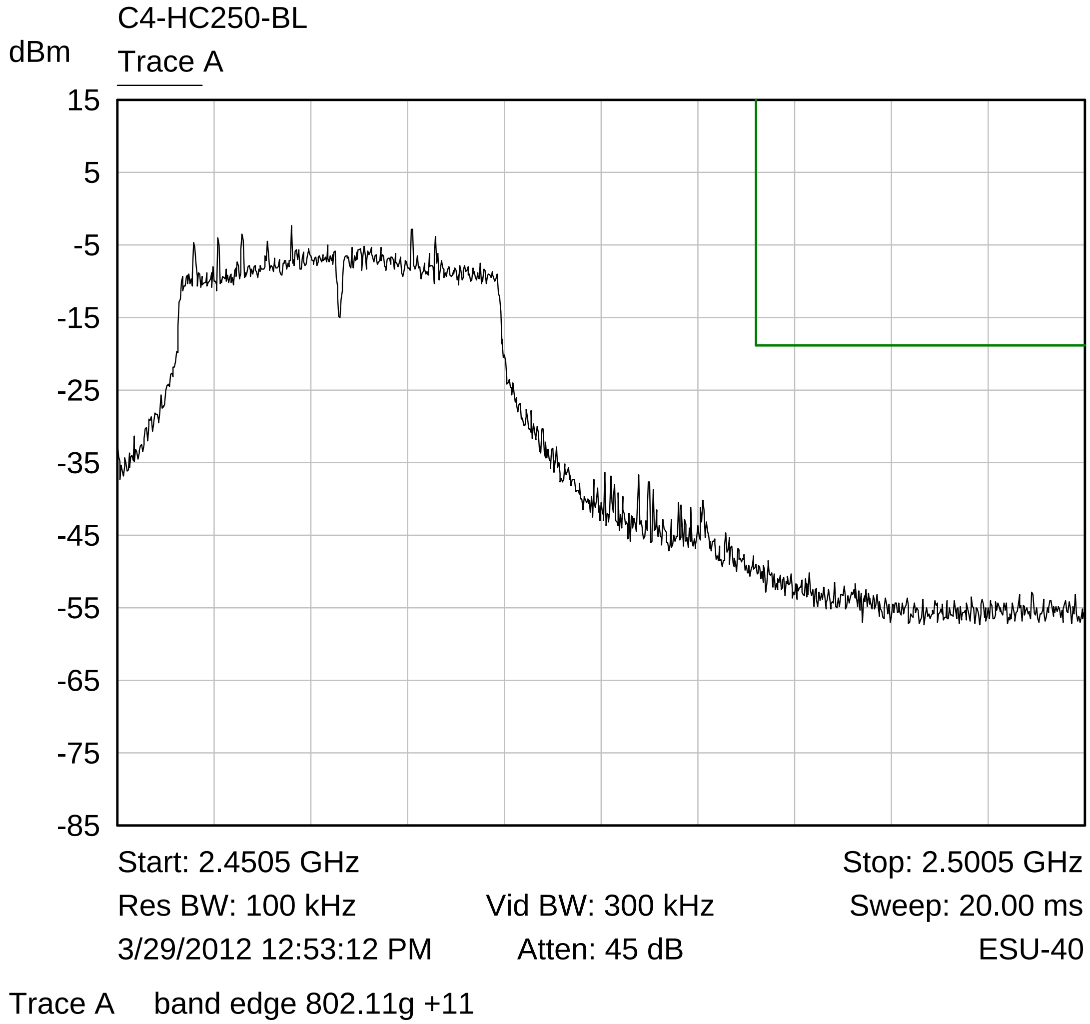
Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4924	-65.2	-18.9
7386	-66.6	-18.9
9848	-66.5	-18.9
12310	-65.3	-18.9
14772	-65.9	-18.9
17234	-65.0	-18.9
19696	-64.2	-18.9
22158	-64.3	-18.9
24620	-62.8	-18.9

Lower Band Edge Plot – 802.11g



Trace A band edge 802.11g +11

Upper Band Edge Plot – 802.11g



6.2.5.1.3 802.11n Mode

Transmitting on the Lowest Channel (2412 MHz) 802.11n

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4824	-65.7	-20.8
7236	-65.4	-20.8
9648	-67.2	-20.8
12060	-65.9	-20.8
14472	-65.6	-20.8

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
16884	-65.7	-20.8
19296	-65.2	-20.8
21708	-65.2	-20.8
24120	-62.6	-20.8

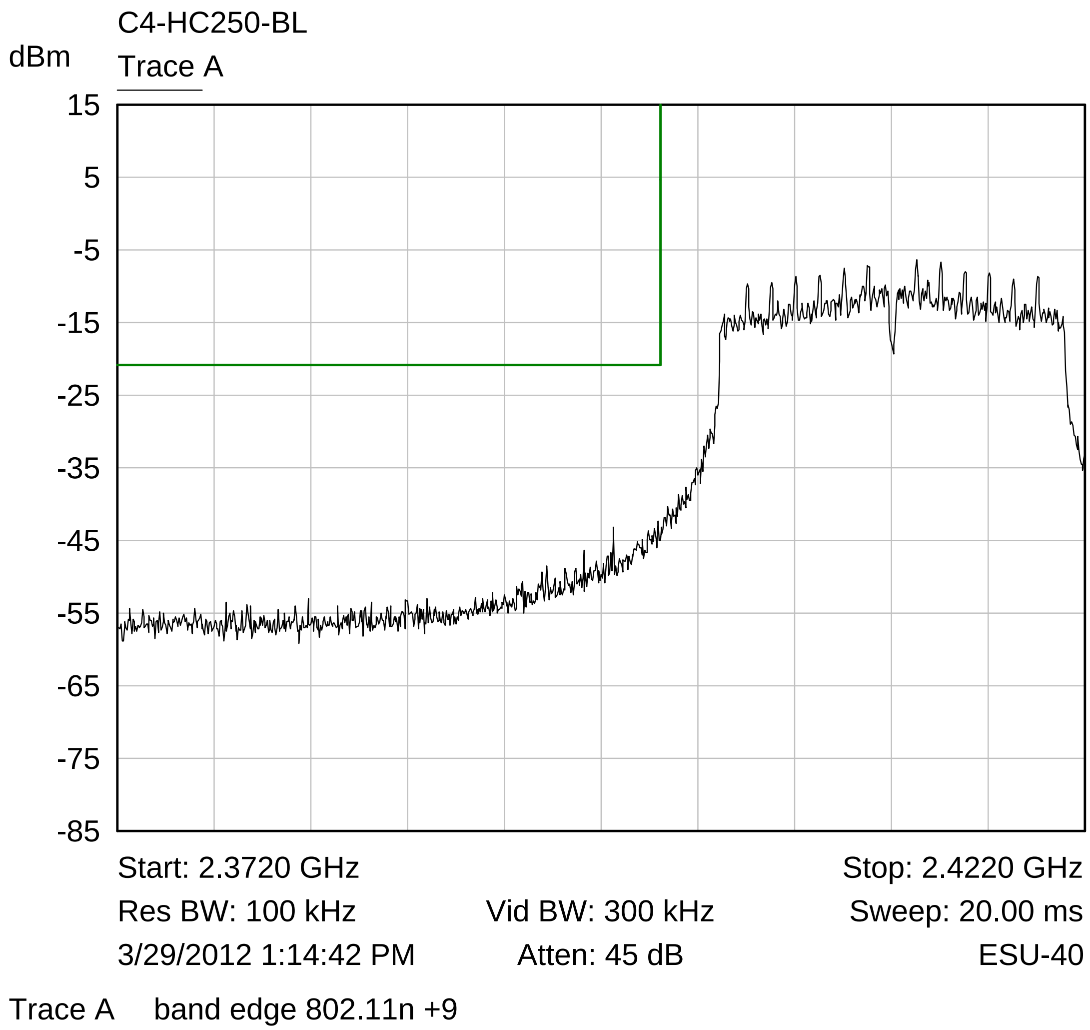
Transmitting on the Middle Channel (2437 MHz) 802.11n

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4874	-66.4	-20.8
7311	-66.3	-20.8
9748	-66.6	-20.8
12185	-66.0	-20.8
14662	-64.6	-20.8
17059	-64.5	-20.8
19496	-65.2	-20.8
21993	-64.2	-20.8
24370	-63.2	-20.8

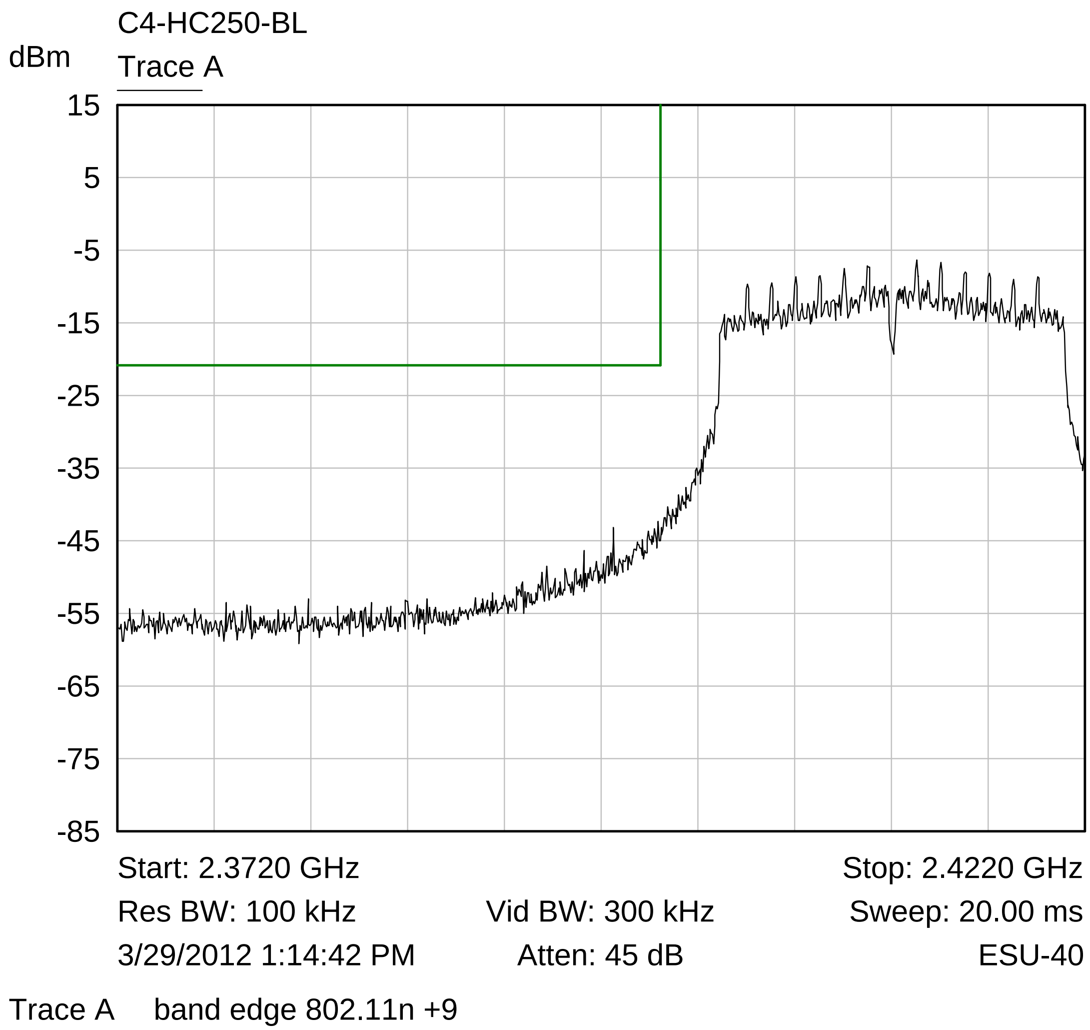
Transmitting on the Highest Channel (2462 MHz) 802.11n

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4924	-65.6	-20.8
7386	-66.4	-20.8
9848	-67.0	-20.8
12310	-65.3	-20.8
14772	-66.1	-20.8
17234	-64.7	-20.8
19696	-65.3	-20.8
22158	-65.5	-20.8
24620	-63.1	-20.8

Lower Band Edge Plot – 802.11n



Upper Band Edge Plot – 802.11n



6.2.5.2 Radiated Emissions in the Restricted Bands of §15.205

The frequency range from 150 kHz 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-HC250-BL. 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 from 150 kHz to 30 MHz RBW = 9 kHz and VBW = 30 kHz. For frequencies from 30 to 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

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	13.4	37.8	51.2	74.0	-22.8
4824.0	Average	Vertical	10.3	37.8	48.1	54.0	-5.9
4824.0	Peak	Horizontal	9.8	37.8	47.6	74.0	-26.4
4824.0	Average	Horizontal	5.8	37.8	43.6	54.0	-10.4
7236.0	Peak	Vertical	3.6	42.7	46.3	74.0	-27.7
7236.0	Average	Vertical	-6.3	42.7	36.4	54.0	-17.6

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
7236.0	Peak	Horizontal	3.3	42.7	46.0	74.0	-28.0
7236.0	Average	Horizontal	-8.7	42.7	34.0	54.0	-20.0
12060.0	Peak	Vertical	0.8	47.1	47.9	74.0	-26.1
12060.0	Average	Vertical	-11.3	47.1	35.8	54.0	-18.2
12060.0	Peak	Horizontal	1.4	47.1	48.5	74.0	-25.5
12060.0	Average	Horizontal	-11.1	47.1	36.0	54.0	-18.0

Transmitting at the Middle Frequency (2437 MHz)

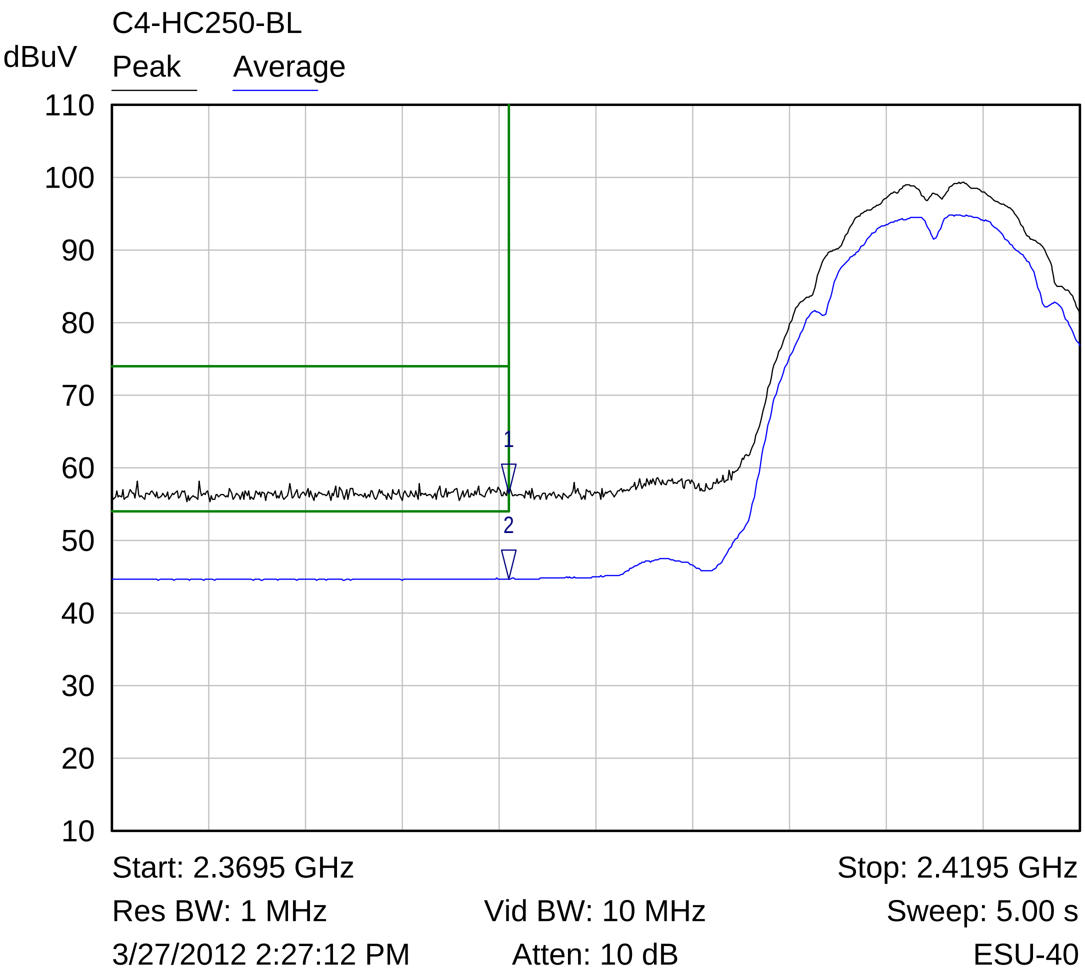
Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4874.0	Peak	Vertical	9.3	37.9	47.2	74.0	-26.8
4874.0	Average	Vertical	5.5	37.9	43.4	54.0	-10.6
4874.0	Peak	Horizontal	5.7	37.9	43.6	74.0	-30.4
4874.0	Average	Horizontal	0.5	37.9	38.4	54.0	-15.6
7311.0	Peak	Vertical	3.3	41.7	45.0	74.0	-29.0
7311.0	Average	Vertical	-8.5	41.7	33.2	54.0	-20.8
7311.0	Peak	Horizontal	3.2	41.7	44.9	74.0	-29.1
7311.0	Average	Horizontal	-9.6	41.7	32.1	54.0	-21.9
12185.0	Peak	Vertical	0.8	47.0	47.8	74.0	-26.2
12185.0	Average	Vertical	-11.6	47.0	35.4	54.0	-18.6
12185.0	Peak	Horizontal	0.4	47.0	47.4	74.0	-26.6
12185.0	Average	Horizontal	-11.7	47.0	35.3	54.0	-18.7

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	8.5	38.0	46.5	74.0	-27.5
4924.0	Average	Vertical	4.3	38.0	42.3	54.0	-11.7
4924.0	Peak	Horizontal	5.6	38.0	43.6	74.0	-30.4
4924.0	Average	Horizontal	-1.3	38.0	36.7	54.0	-17.3
7386.0	Peak	Vertical	2.7	42.7	45.4	74.0	-28.6
7386.0	Average	Vertical	-9.5	42.7	33.2	54.0	-20.8
7386.0	Peak	Horizontal	2.1	42.7	44.8	74.0	-29.2
7386.0	Average	Horizontal	-10.3	42.7	32.4	54.0	-21.6
12310.0	Peak	Vertical	1.0	47.0	48.0	74.0	-26.0
12310.0	Average	Vertical	-11.4	47.0	35.6	54.0	-18.4
12310.0	Peak	Horizontal	0.4	47.0	47.4	74.0	-26.6
12310.0	Average	Horizontal	-11.4	47.0	35.6	54.0	-18.4

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.

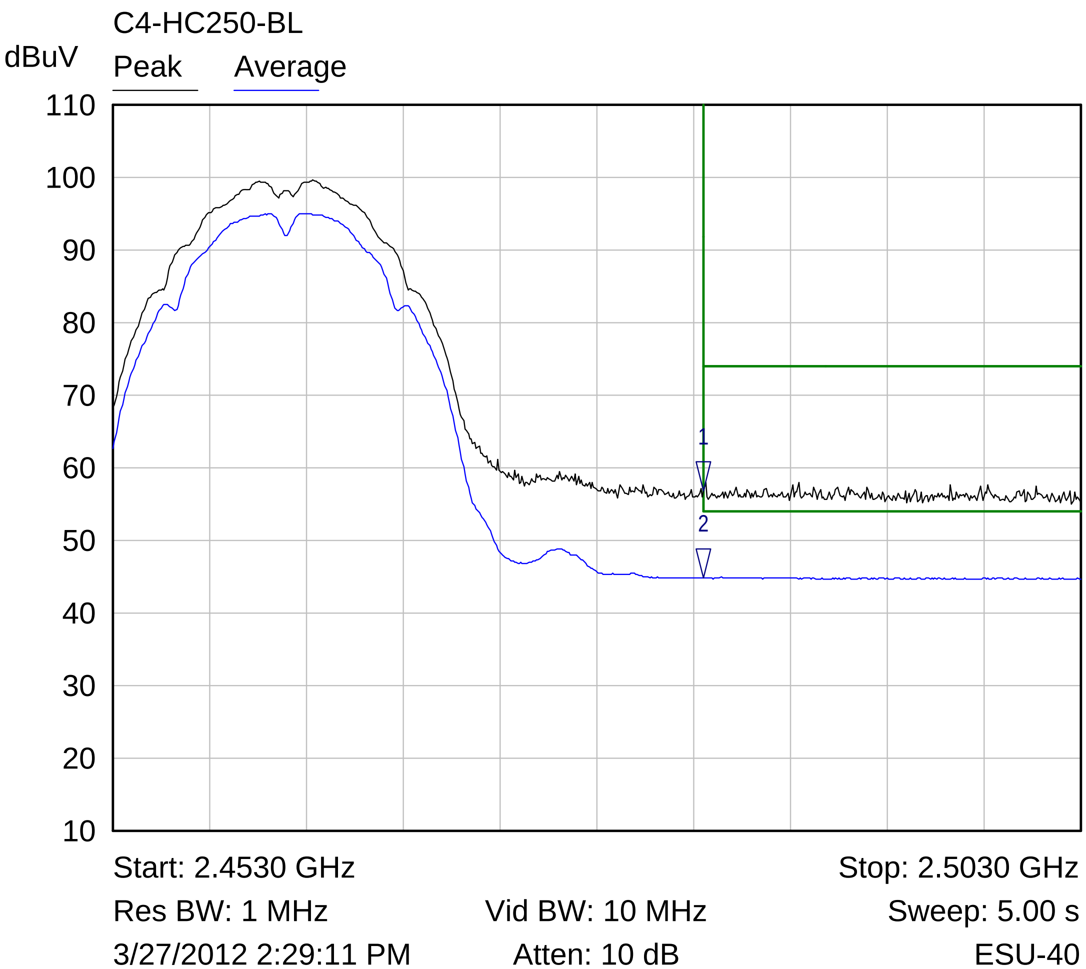
Radiated Lower Band Edge Plot



Mkr	Trace	X-Axis	Value	Notes
1 ∇	Peak	2.3900 GHz	56.42 dBuV	
2 ∇	Average	2.3900 GHz	44.73 dBuV	

802.11b, +12 power setting

Radiated Upper Band Edge Plot



Mkr	Trace	X-Axis	Value	Notes
1 ∇	Peak	2.4835 GHz	56.77 dBuV	
2 ∇	Average	2.4835 GHz	44.86 dBuV	

802.11b, +12 power setting

6.2.5.2.2 802.11g

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	11.6	37.8	49.4	74.0	-24.6
4824.0	Average	Vertical	6.7	37.8	44.5	54.0	-9.5
4824.0	Peak	Horizontal	8.5	37.8	46.3	74.0	-27.7
4824.0	Average	Horizontal	-2.2	37.8	35.6	54.0	-18.4
7236.0	Peak	Vertical	18.3	42.7	61.0	74.0	-13.0
7236.0	Average	Vertical	4.7	42.7	47.4	54.0	-6.6
7236.0	Peak	Horizontal	13.1	42.7	55.8	74.0	-18.2
7236.0	Average	Horizontal	-0.3	42.7	42.4	54.0	-11.6
12060.0	Peak	Vertical	3.9	47.1	51.0	74.0	-23.0
12060.0	Average	Vertical	-7.6	47.1	39.5	54.0	-14.5
12060.0	Peak	Horizontal	2.1	47.1	49.2	74.0	-24.8
12060.0	Average	Horizontal	-9.2	47.1	37.9	54.0	-16.1

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	15.1	37.9	53.0	74.0	-21.0
4874.0	Average	Vertical	4.5	37.9	42.4	54.0	-11.6
4874.0	Peak	Horizontal	9.7	37.9	47.6	74.0	-26.4
4874.0	Average	Horizontal	-1.8	37.9	36.1	54.0	-17.9
7311.0	Peak	Vertical	17.1	41.7	58.8	74.0	-15.2
7311.0	Average	Vertical	3.3	41.7	45.0	54.0	-9.0

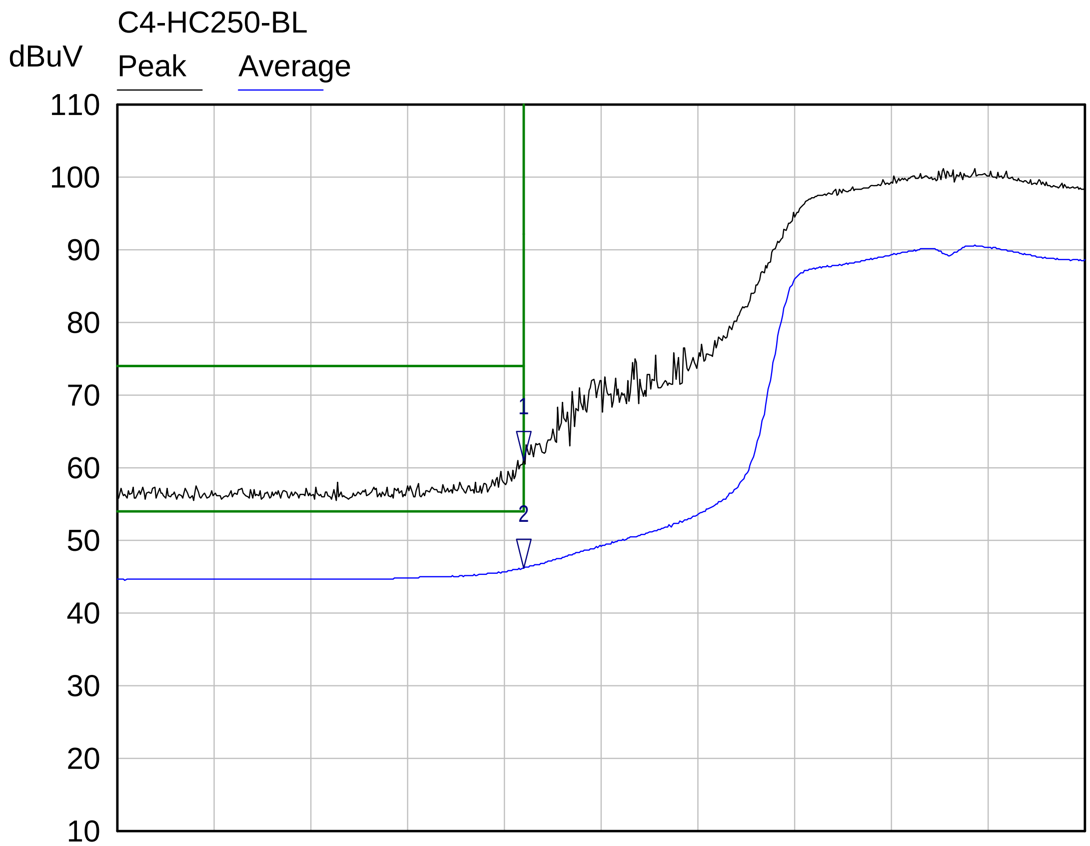
Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
7311.0	Peak	Horizontal	13.9	41.7	55.6	74.0	-18.4
7311.0	Average	Horizontal	-0.7	41.7	41.0	54.0	-13.0
12185.0	Peak	Vertical	2.7	47.0	49.7	74.0	-24.3
12185.0	Average	Vertical	-8.9	47.0	38.1	54.0	-15.9
12185.0	Peak	Horizontal	1.5	47.0	48.5	74.0	-25.5
12185.0	Average	Horizontal	-11.0	47.0	36.0	54.0	-18.0

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	13.9	38.0	51.9	74.0	-22.1
4924.0	Average	Vertical	2.9	38.0	40.9	54.0	-13.1
4924.0	Peak	Horizontal	12.4	38.0	50.4	74.0	-23.6
4924.0	Average	Horizontal	1.4	38.0	39.4	54.0	-14.6
7386.0	Peak	Vertical	16.0	42.7	58.7	74.0	-15.3
7386.0	Average	Vertical	2.7	42.7	45.4	54.0	-8.6
7386.0	Peak	Horizontal	11.0	42.7	53.7	74.0	-20.3
7386.0	Average	Horizontal	-1.5	42.7	41.2	54.0	-12.8
12310.0	Peak	Vertical	1.3	47.0	48.3	74.0	-25.7
12310.0	Average	Vertical	-9.6	47.0	37.4	54.0	-16.6
12310.0	Peak	Horizontal	1.8	47.0	48.8	74.0	-25.2
12310.0	Average	Horizontal	-9.7	47.0	37.3	54.0	-16.7

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

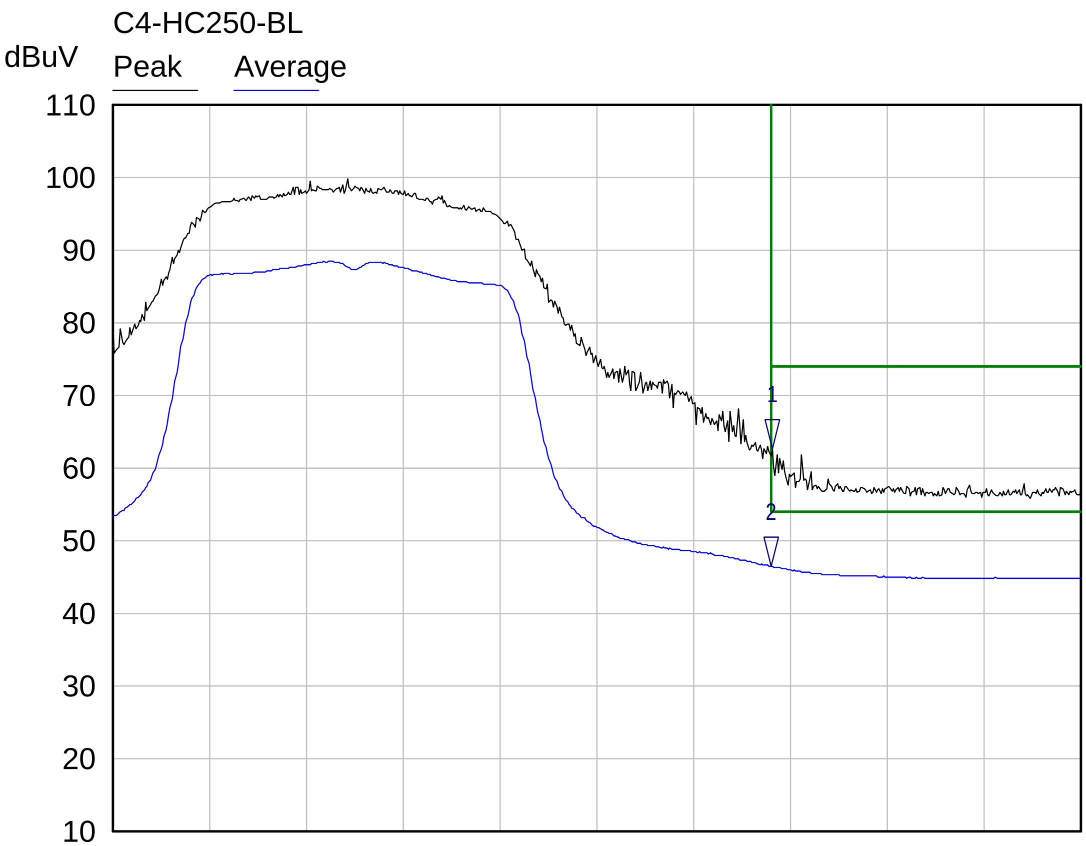


Start: 2.3690 GHz | Stop: 2.4190 GHz
Res BW: 1 MHz | Vid BW: 10 MHz | Sweep: 5.00 s
3/27/2012 2:11:56 PM | Atten: 10 dB | ESU-40

Mkr	Trace	X-Axis	Value	Notes
1 ∇	Peak	2.3900 GHz	60.92 dBuV	
2 ∇	Average	2.3900 GHz	46.16 dBuV	

802.11g, +11 power setting

Radiated Upper Band Edge Plot



Start: 2.4495 GHz — Stop: 2.4995 GHz
Res BW: 1 MHz — Vid BW: 3 MHz — Sweep: 5.00 s
3/27/2012 2:07:19 PM — Atten: 10 dB — ESU-40

Mkr	Trace	X-Axis	Value	Notes
1 ▽	Peak	2.4836 GHz	62.63 dBuV	
2 ▽	Average	2.4835 GHz	46.46 dBuV	

802.11g, +11 power setting

6.2.5.2.3 802.11n

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	11.8	37.8	49.6	74.0	-24.4
4824.0	Average	Vertical	1.1	37.8	38.9	54.0	-15.1
4824.0	Peak	Horizontal	7.8	37.8	45.6	74.0	-28.4
4824.0	Average	Horizontal	-3.2	37.8	34.6	54.0	-19.4
7236.0	Peak	Vertical	17.8	42.7	60.5	74.0	-13.5
7236.0	Average	Vertical	3.5	42.7	46.2	54.0	-7.8
7236.0	Peak	Horizontal	11.7	42.7	54.4	74.0	-19.6
7236.0	Average	Horizontal	-1.6	42.7	41.1	54.0	-12.9
12060.0	Peak	Vertical	3.4	47.1	50.5	74.0	-23.5
12060.0	Average	Vertical	-8.0	47.1	39.1	54.0	-14.9
12060.0	Peak	Horizontal	1.6	47.1	48.7	74.0	-25.3
12060.0	Average	Horizontal	-9.2	47.1	37.9	54.0	-16.1

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	15.2	37.9	53.1	74.0	-20.9
4874.0	Average	Vertical	1.3	37.9	39.2	54.0	-14.8
4874.0	Peak	Horizontal	9.3	37.9	47.2	74.0	-26.8
4874.0	Average	Horizontal	-3.6	37.9	34.3	54.0	-19.7
7311.0	Peak	Vertical	17.0	41.7	58.7	74.0	-15.3
7311.0	Average	Vertical	2.5	41.7	44.2	54.0	-9.8

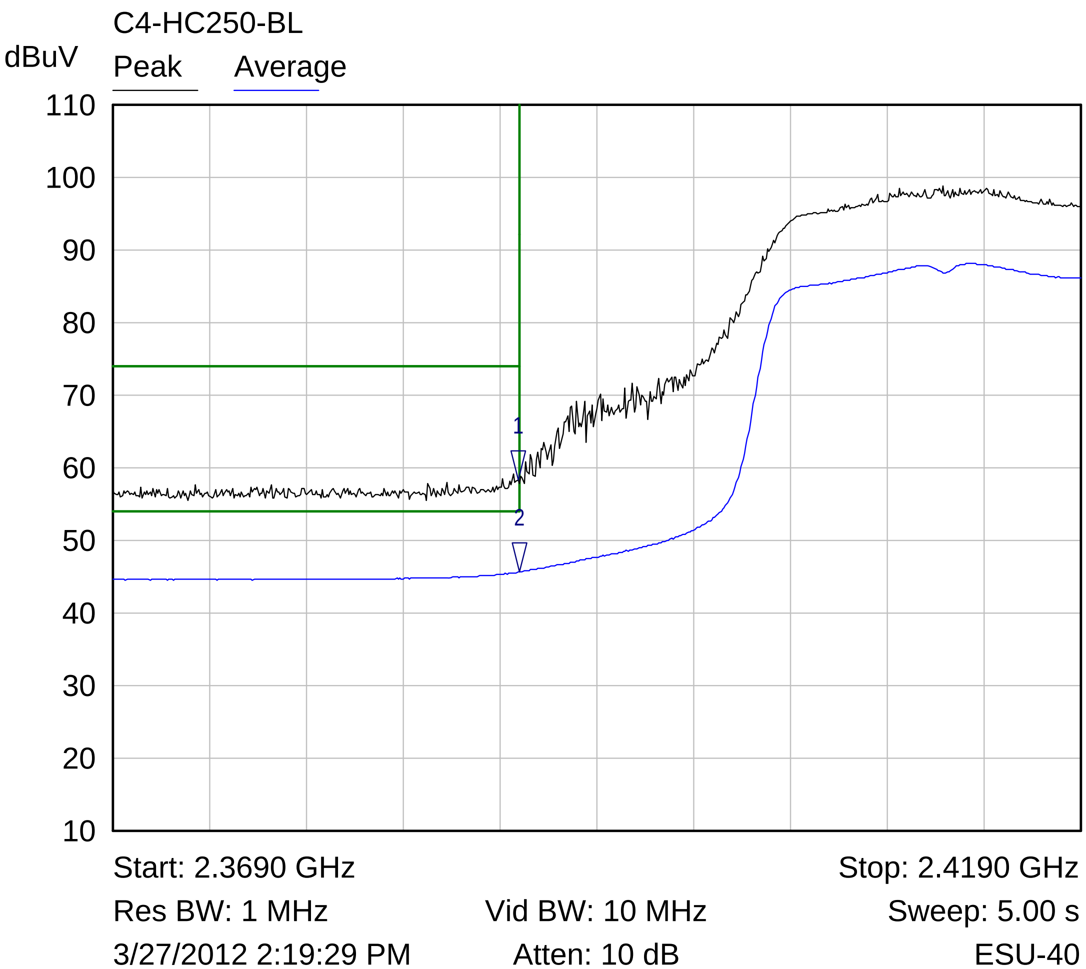
Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
7311.0	Peak	Horizontal	12.7	41.7	54.4	74.0	-19.6
7311.0	Average	Horizontal	-6.6	41.7	35.1	54.0	-18.9
12185.0	Peak	Vertical	1.9	47.0	48.9	74.0	-25.1
12185.0	Average	Vertical	-7.9	47.0	39.1	54.0	-14.9
12185.0	Peak	Horizontal	1.5	47.0	48.5	74.0	-25.5
12185.0	Average	Horizontal	-10.2	47.0	36.8	54.0	-17.2

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	38.0	51.3	74.0	-22.7
4924.0	Average	Vertical	3.1	38.0	41.1	54.0	-12.9
4924.0	Peak	Horizontal	11.6	38.0	49.6	74.0	-24.4
4924.0	Average	Horizontal	1.1	38.0	39.1	54.0	-14.9
7386.0	Peak	Vertical	16.1	42.7	58.8	74.0	-15.2
7386.0	Average	Vertical	2.9	42.7	45.6	54.0	-8.4
7386.0	Peak	Horizontal	12.2	42.7	54.9	74.0	-19.1
7386.0	Average	Horizontal	-0.5	42.7	42.2	54.0	-11.8
12310.0	Peak	Vertical	3.1	47.0	50.1	74.0	-23.9
12310.0	Average	Vertical	-7.7	47.0	39.3	54.0	-14.7
12310.0	Peak	Horizontal	1.8	47.0	48.8	74.0	-25.2
12310.0	Average	Horizontal	-9.9	47.0	37.1	54.0	-16.9

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.

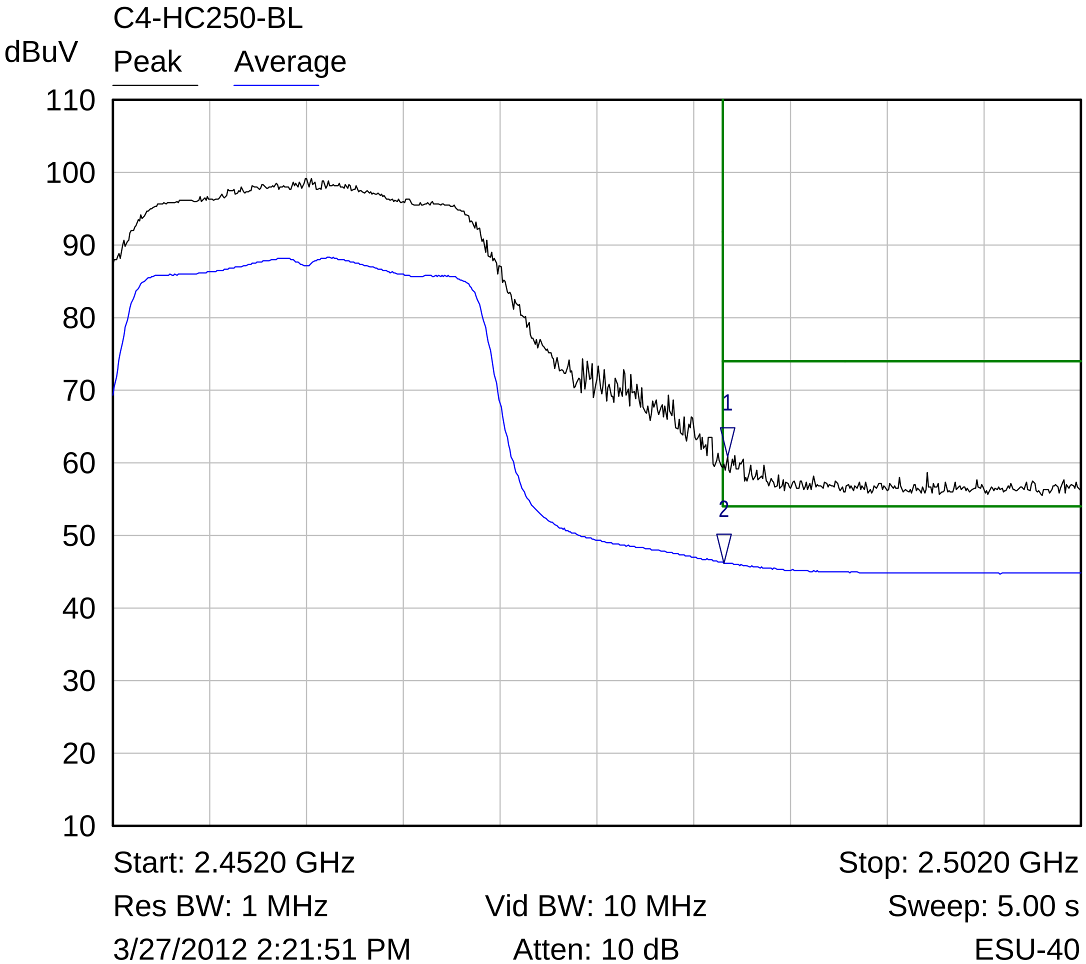
Radiated Lower Band Edge Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Peak	2.3899 GHz	58.27 dBuV	
2 ▽	Average	2.3900 GHz	45.64 dBuV	

802.11n, +9 power setting

Radiated Upper Band Edge Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Peak	2.4837 GHz	60.90 dBuV	
2 ▽	Average	2.4836 GHz	46.20 dBuV	

802.11n, +9 power setting

6.2.6 §15.247(d) Peak Power Spectral Density

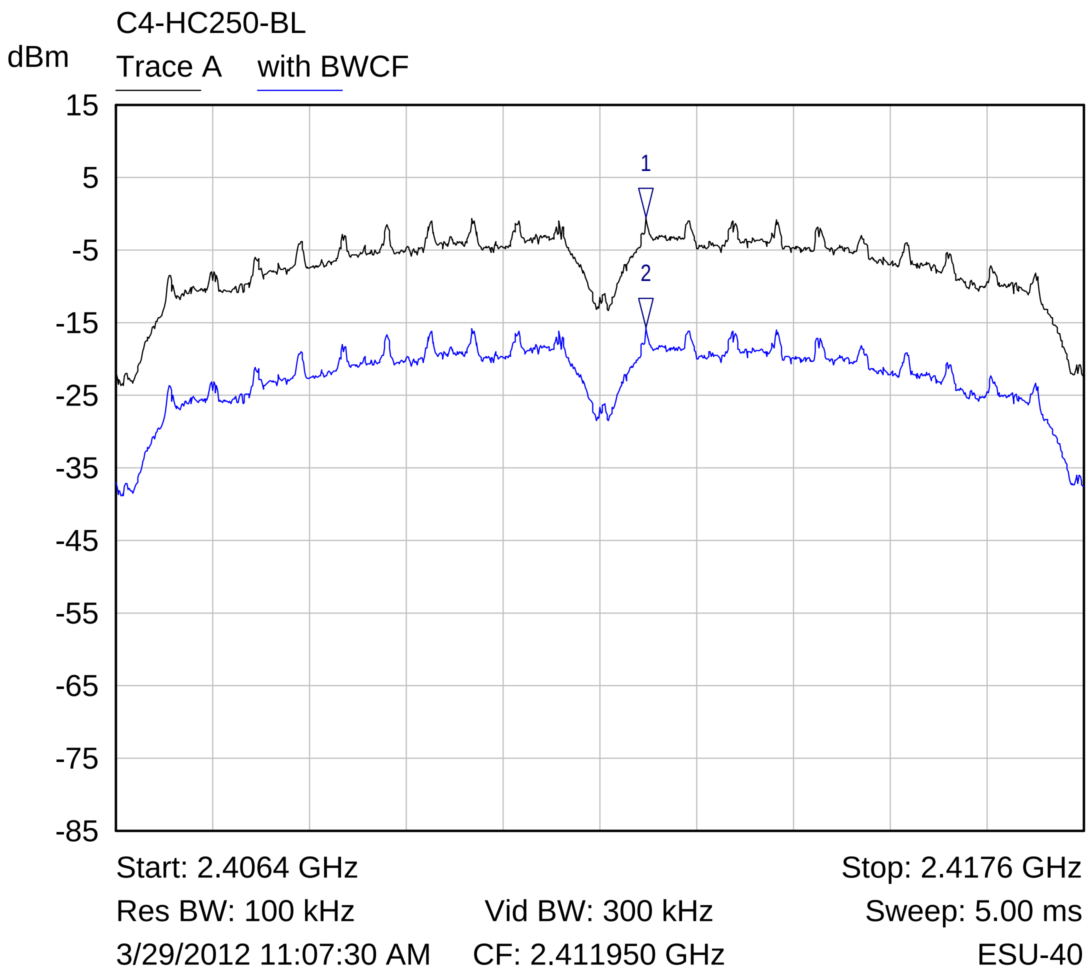
The peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. KDB 558074 DTS D01 Measurement Guidance v01 5.3.1was used to measure the 3 kHz power spectral density of the emission. The result of this testing is summarized in the table below.

Frequency (MHz)	802.11b Measurement (dBm)	802.11g Measurement (dBm)	802.11n Measurement (dBm)
2412	-15.73	-18.08	-21.27
2437	-15.51	-17.35	-19.59
2462	-14.16	-16.37	-18.83

RESULT

The maximum peak power spectral density was -14.16 dBm. The EUT complies with the specification by 22.16 dB.

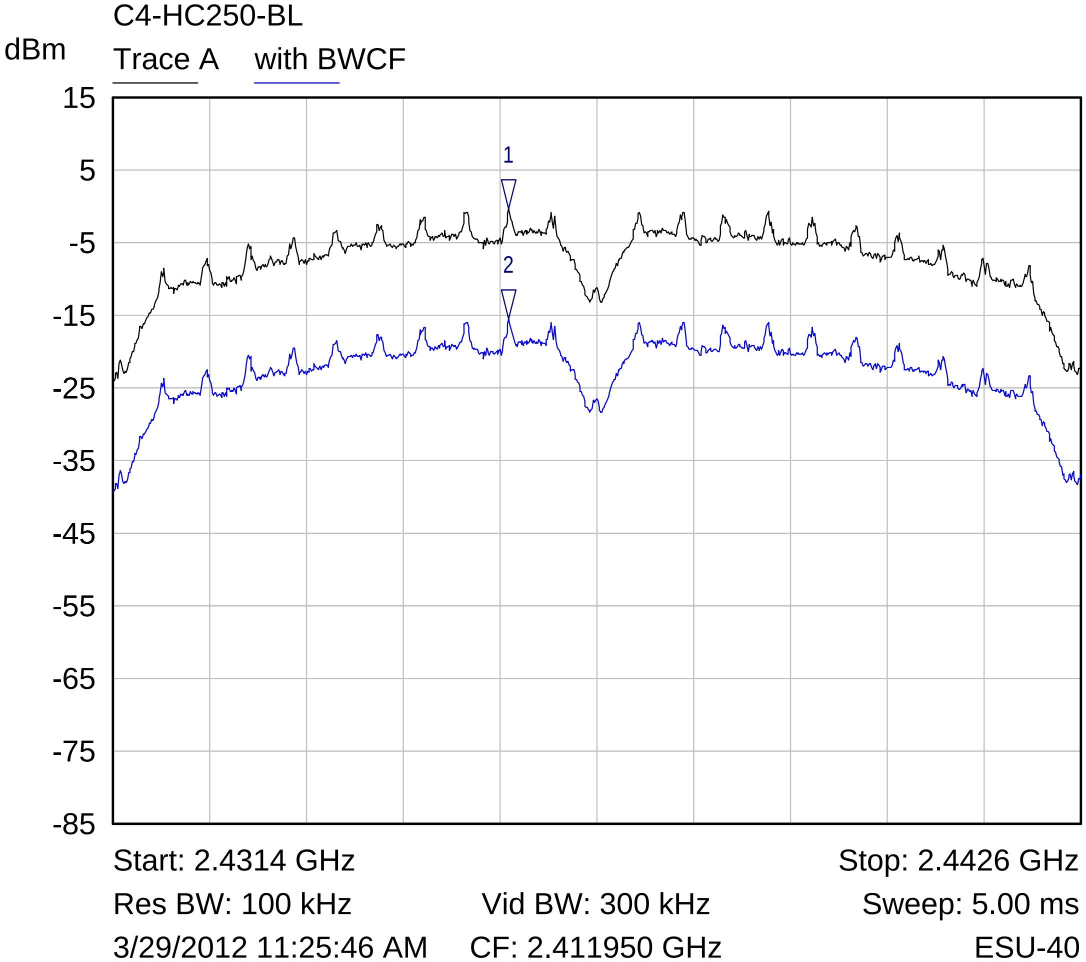
Lowest channel – 802.11b



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4125 GHz	-0.53 dBm	
2 ▽	with BWCF	2.4125 GHz	-15.73 dBm	

Trace A 100k RBW opref 802.11b +12

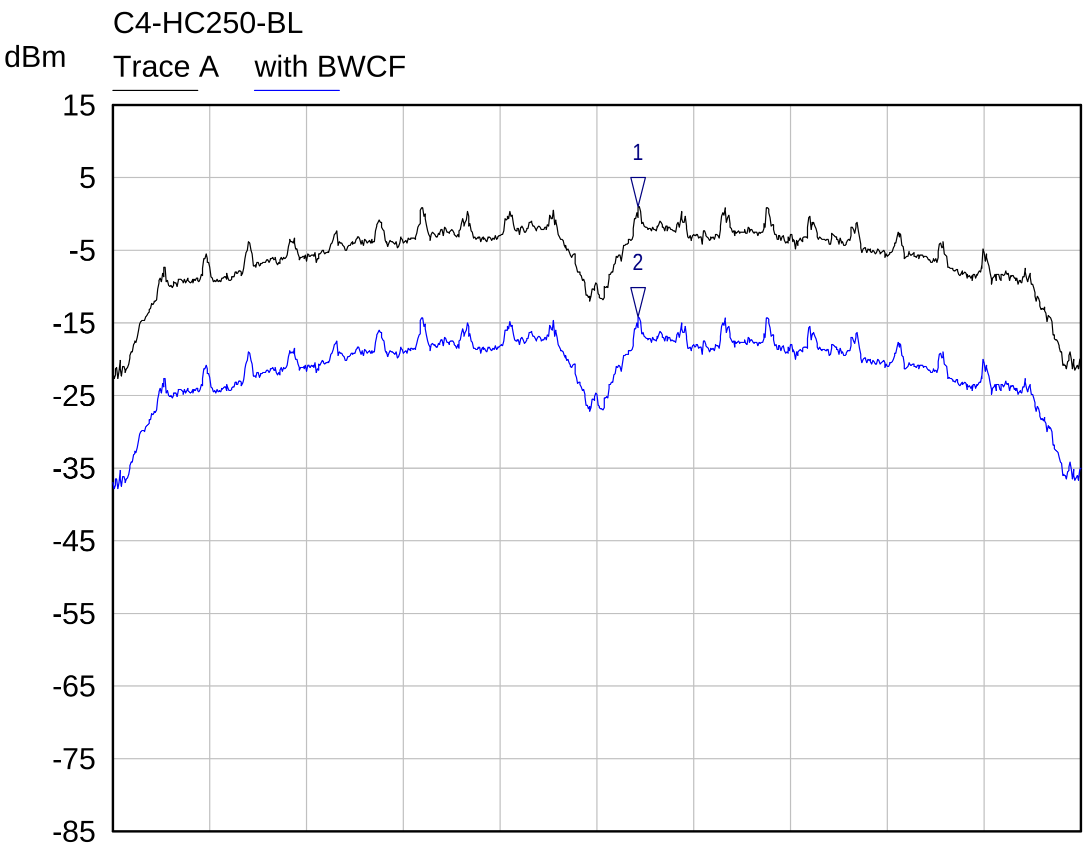
Middle channel – 802.11b



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4360 GHz	-0.31 dBm	
2 ▽	with BWCF	2.4360 GHz	-15.51 dBm	

Trace A psd 802.11b +12

Upper channel – 802.11b

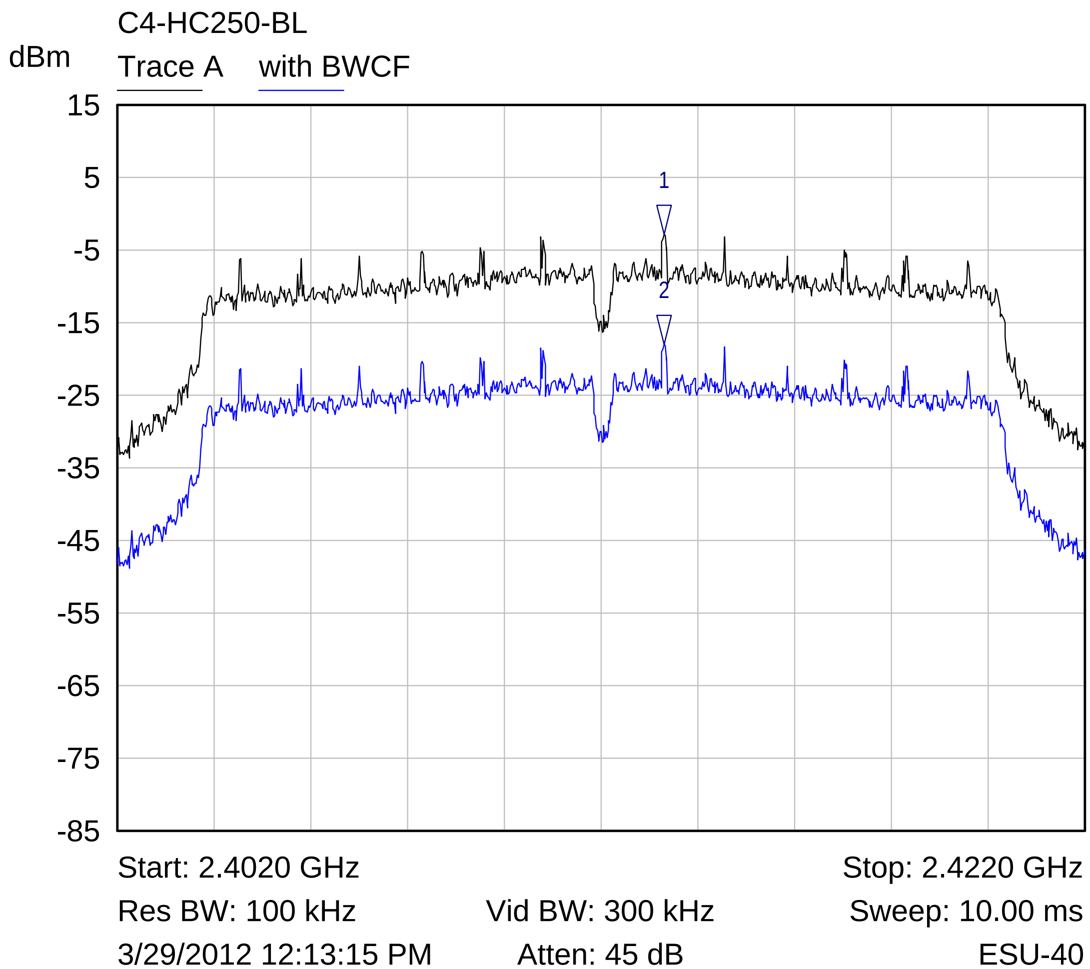


Start: 2.4564 GHz Stop: 2.4676 GHz
Res BW: 100 kHz Vid BW: 300 kHz Sweep: 5.00 ms
3/29/2012 11:41:08 AM CF: 2.411950 GHz ESU-40

Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4625 GHz	1.04 dBm	
2 ▽	with BWCF	2.4625 GHz	-14.16 dBm	

Trace A psd 802.11b +12

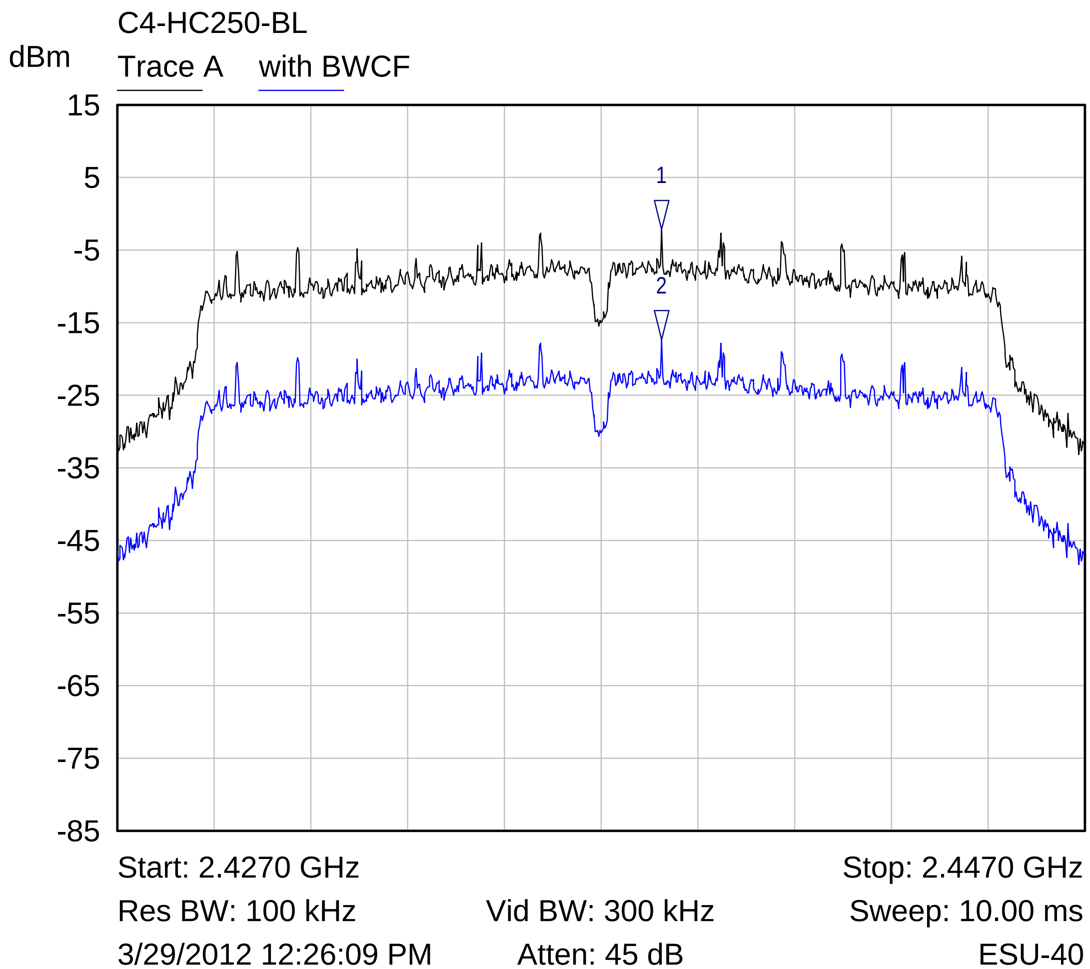
Lower channel – 802.11g



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4133 GHz	-2.88 dBm	
2 ▽	with BWCF	2.4133 GHz	-18.08 dBm	

Trace A PSD 802.11g +11

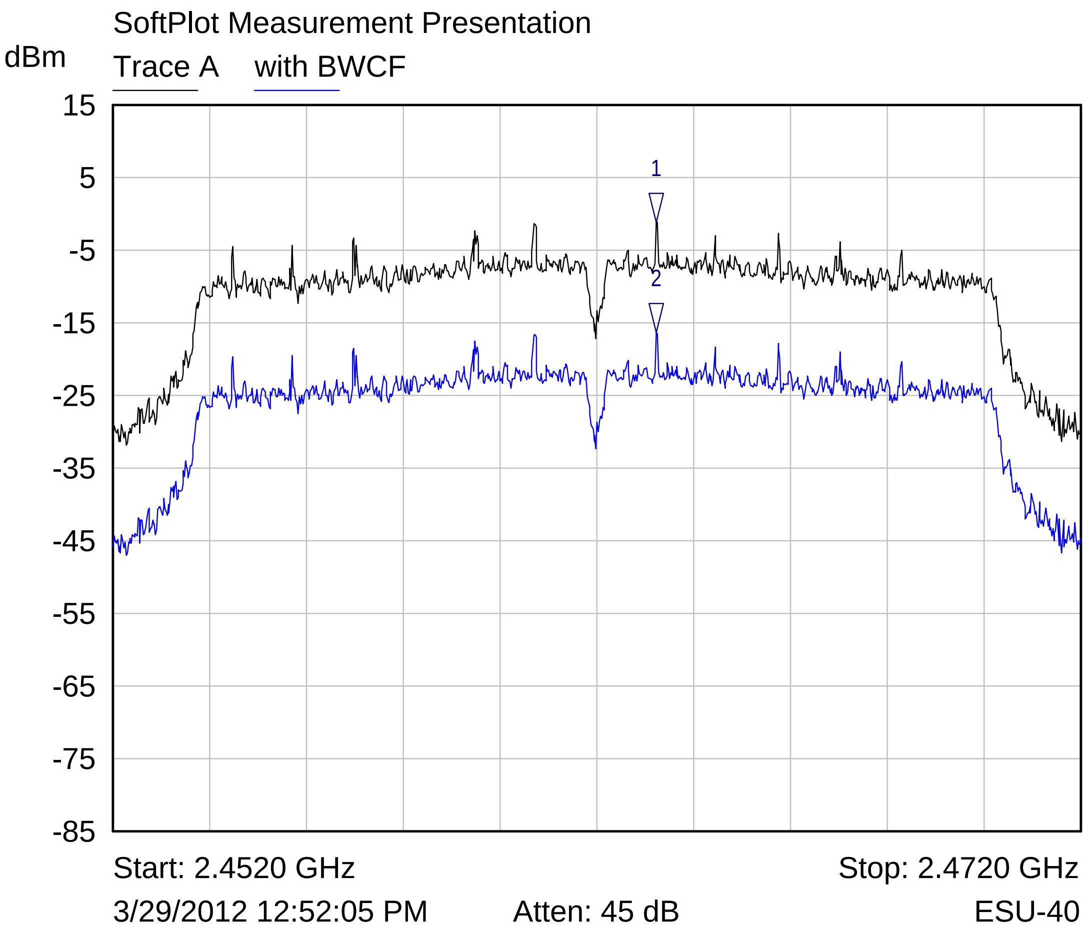
Middle channel – 802.11g



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4382 GHz	-2.15 dBm	
2 ▽	with BWCF	2.4382 GHz	-17.35 dBm	

Trace A PSD 802.11g +11

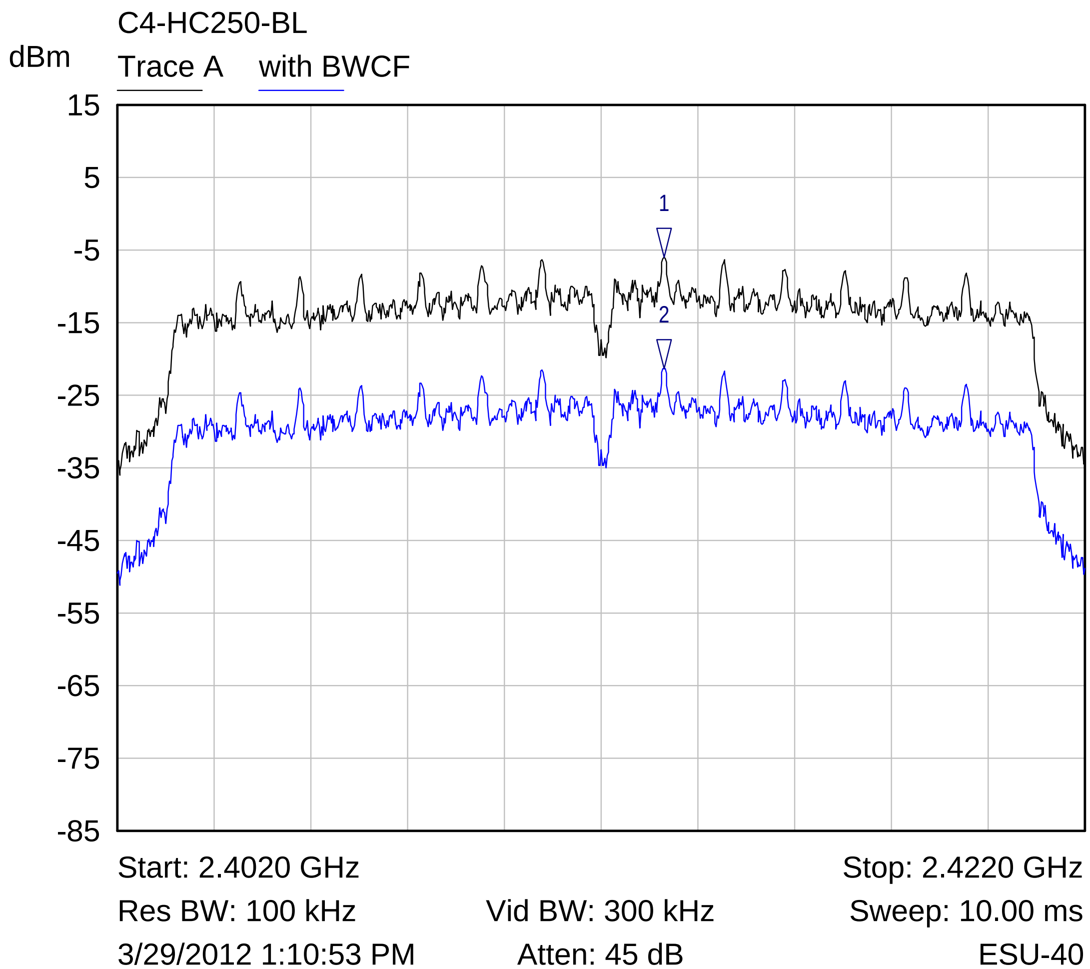
Upper channel – 802.11g



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4632 GHz	-1.17 dBm	
2 ▽	with BWCF	2.4632 GHz	-16.37 dBm	

Trace A psd 802.11g +11

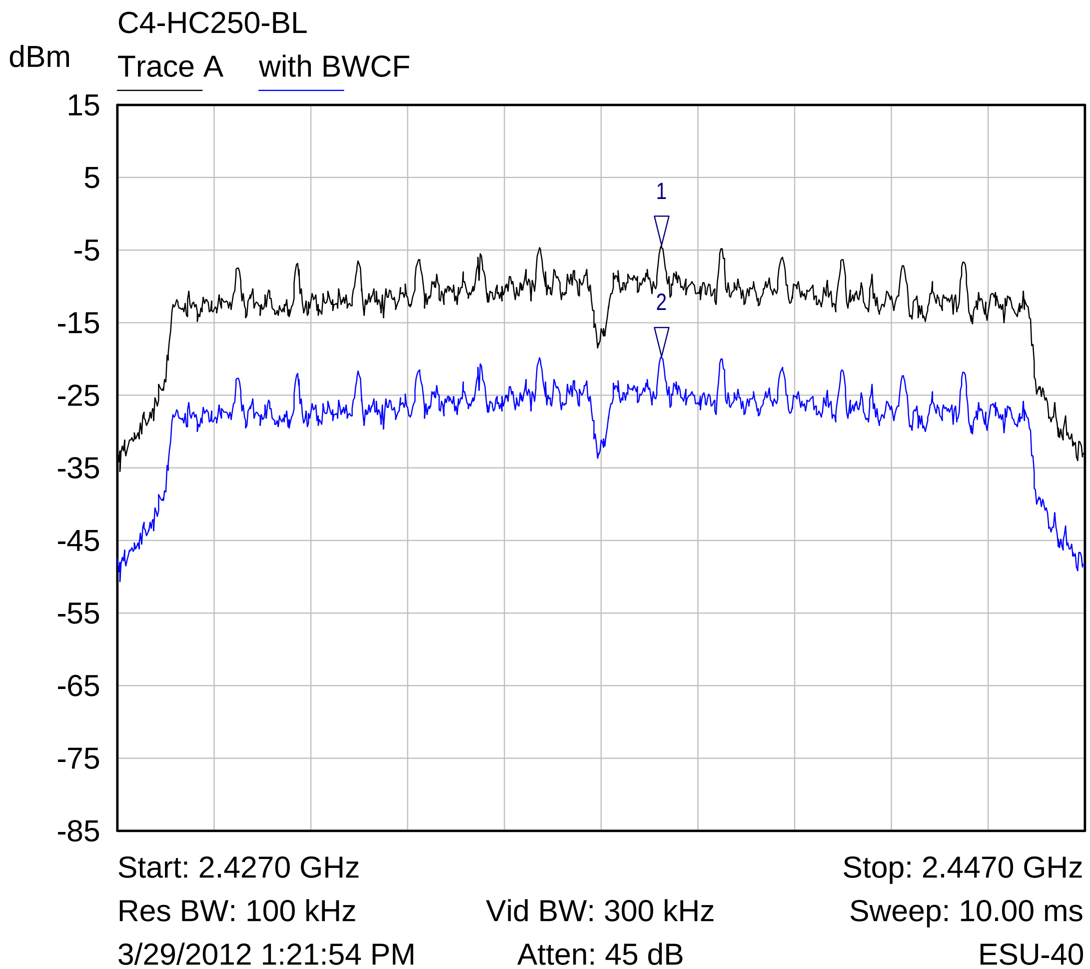
Lower channel – 802.11n



Mkr	Trace	X-Axis	Value	Notes
1 ∇	Trace A	2.4133 GHz	-6.07 dBm	
2 ∇	with BWCF	2.4133 GHz	-21.27 dBm	

Trace A psd 802.11n +9

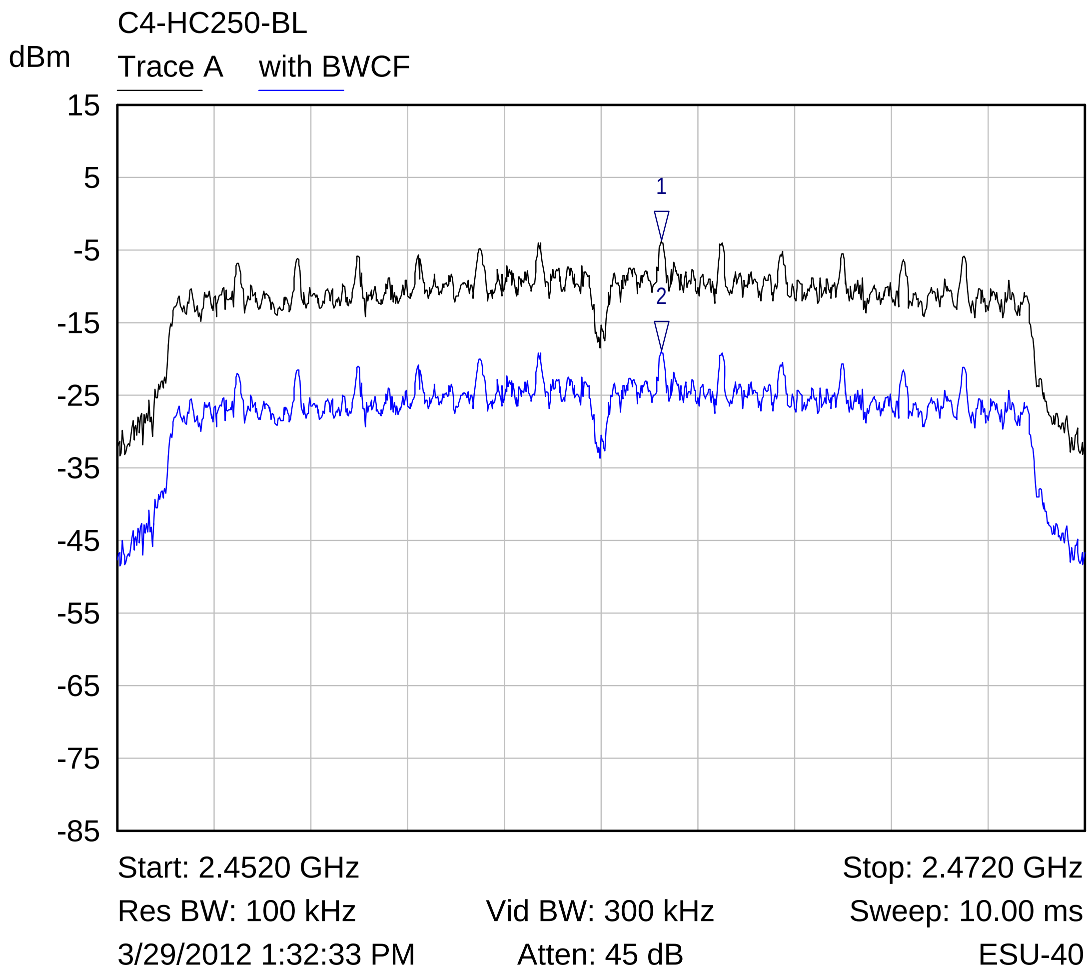
Middle channel – 802.11n



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4382 GHz	-4.39 dBm	
2 ▽	with BWCF	2.4382 GHz	-19.59 dBm	

Trace A psd 802.11n +9

Upper channel – 802.11n



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4632 GHz	-3.63 dBm	
2 ▽	with BWCF	2.4632 GHz	-18.83 dBm	

Trace A psd 802.11n +9

SECTION 7.0 802.15.4 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 an inverted F 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 802.15.4 Zigbee transceiver in a constant transmit mode. No difference was seen in the emissions from testing with the 802.11b/g/n transceiver transmitting constantly. See test data of 6.2.2.

RESULT

The EUT complied with the specification.

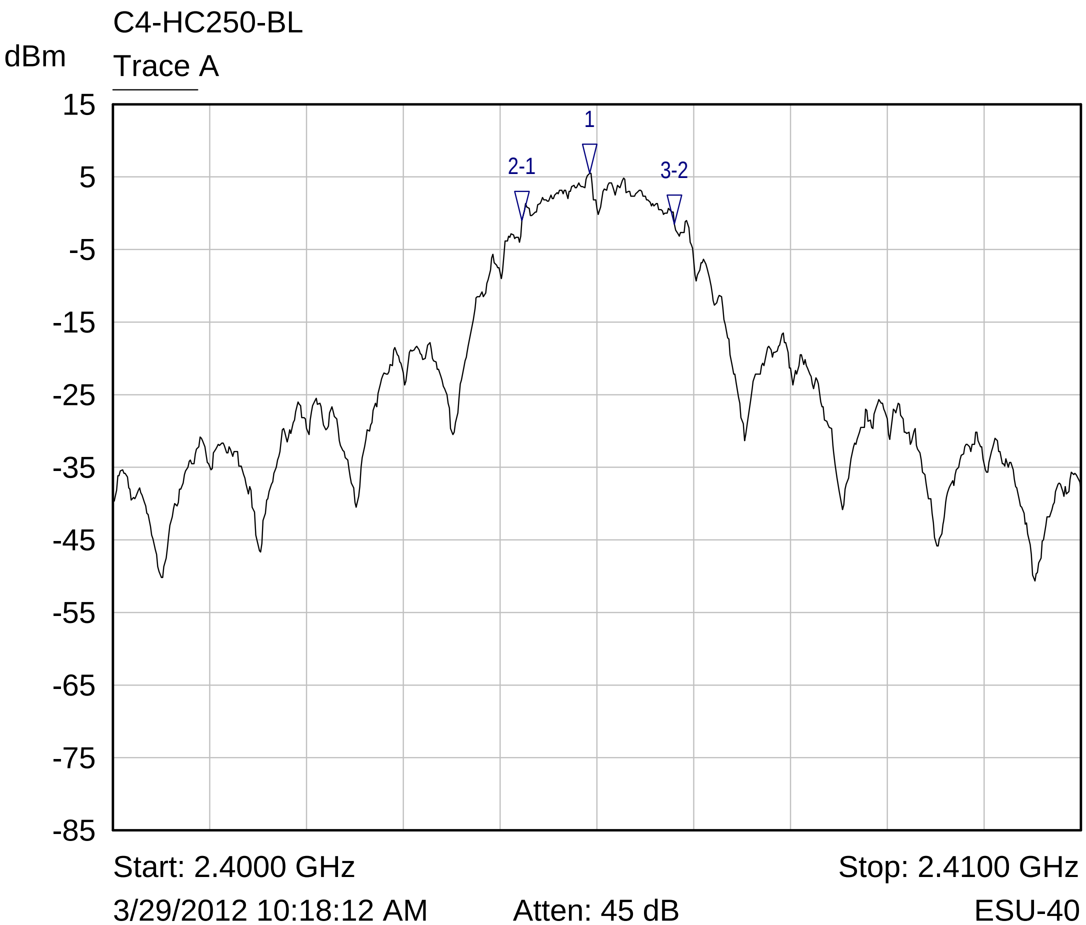
7.2.3 §15.247(a)(2) Emission Bandwidth

Frequency (MHz)	Emission 6dB Bandwidth (kHz)
2405	1570.5
2440	1618.6
2475	1570.5

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).

Lower Channel Bandwidth

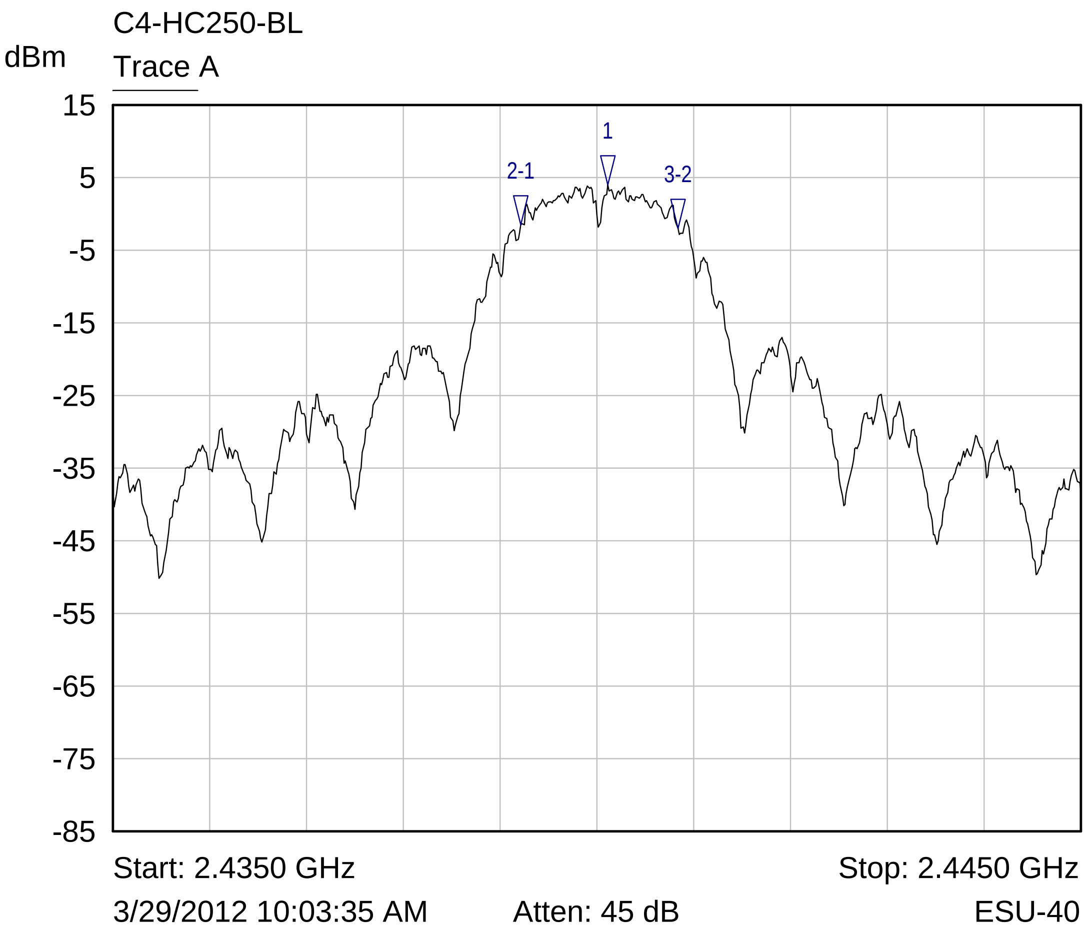


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4049 GHz	5.54 dBm	
2-1 ▽	Trace A	-689.1026 kHz	-6.49 dB	
3-2 ▽	Trace A	1.5705 MHz	-0.53 dB	

discreet filter

Trace A emission 6 dBbandwidth

Middle Channel Bandwidth

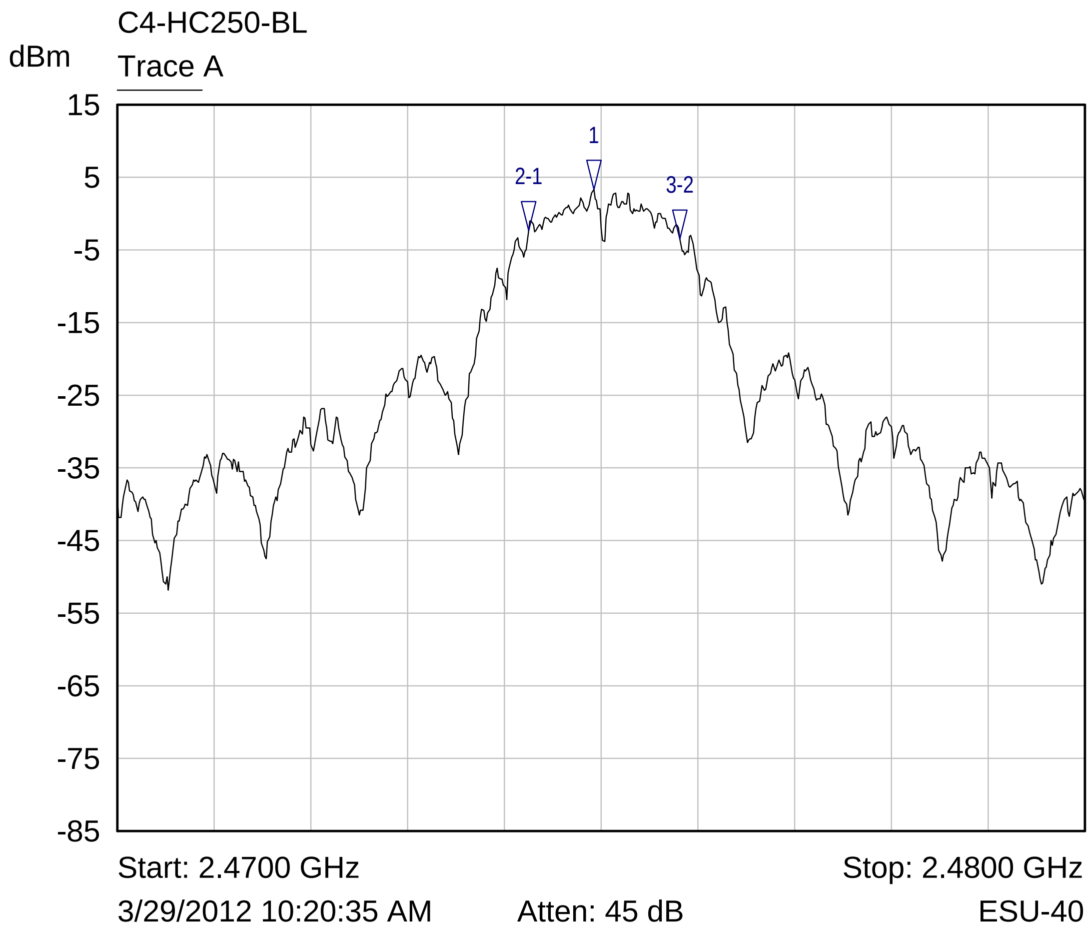


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4401 GHz	4.07 dBm	
2-1 ▽	Trace A	-897.4359 kHz	-5.51 dB	
3-2 ▽	Trace A	1.6186 MHz	-0.57 dB	

discreet filter

Trace A emission 6 dBbandwidth

Upper Channel Bandwidth



Mkr	Trace	X-Axis	Value	Notes
1 ∇	Trace A	2.4749 GHz	3.36 dBm	
2-1 ∇	Trace A	-673.0769 kHz	-5.78 dB	
3-2 ∇	Trace A	1.5705 MHz	-1.16 dB	

discreet filter

Trace A emission 6 dBbandwidth

7.2.4 §15.247(b)(3) Peak Output Power

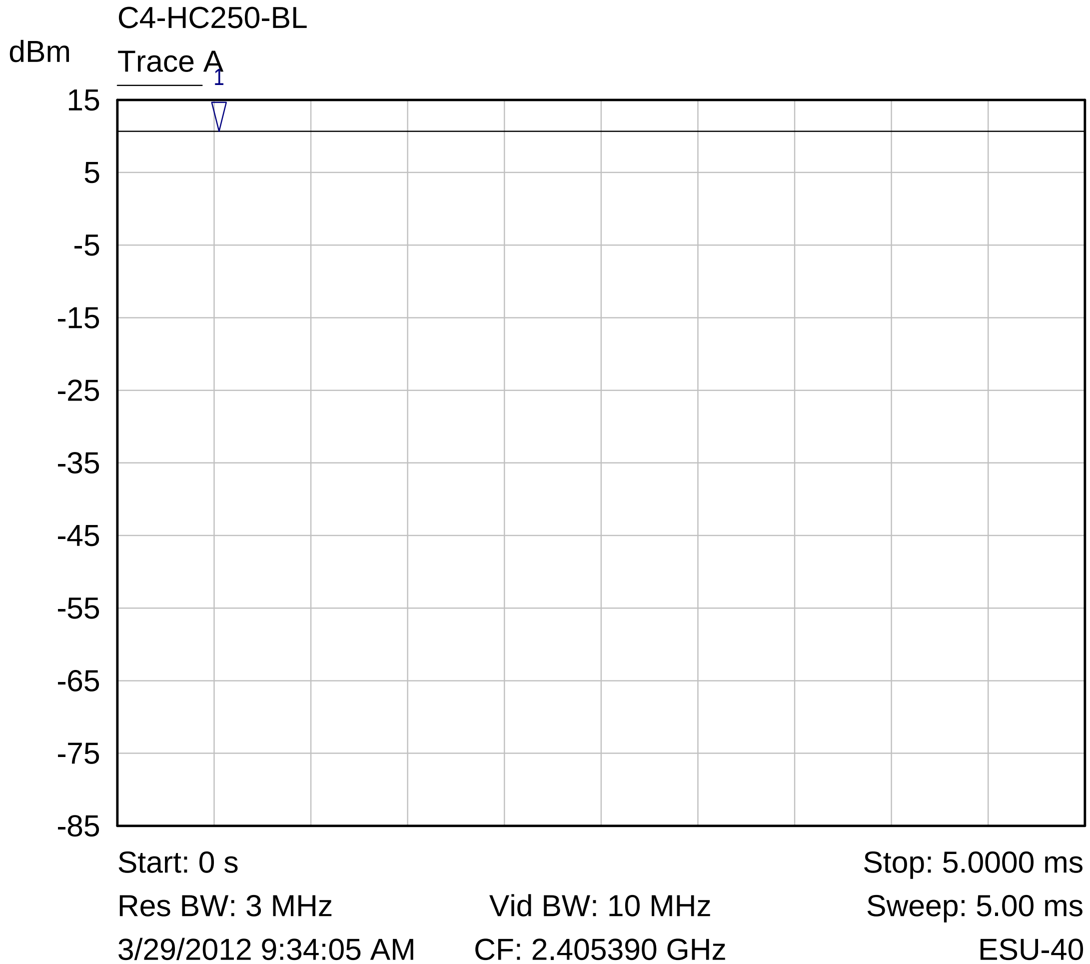
The maximum peak RF Conducted output power measured for this device was 11.78 mW or 10.71 dBm. The limit is 30 dBm or 1 Watt when using antennas with 6 dBi or less gain. The Zigbee antenna has a gain of 0.07 dBi. Measurements were made using 558074 D01 DTS Measurement Guidance v01 5.2.1.1.

Frequency (MHz)	Measured Output Power (dBm)	Measured Output Power (mW)
2405	10.71	11.78
2440	10.07	10.16
2475	8.38	6.89

RESULT

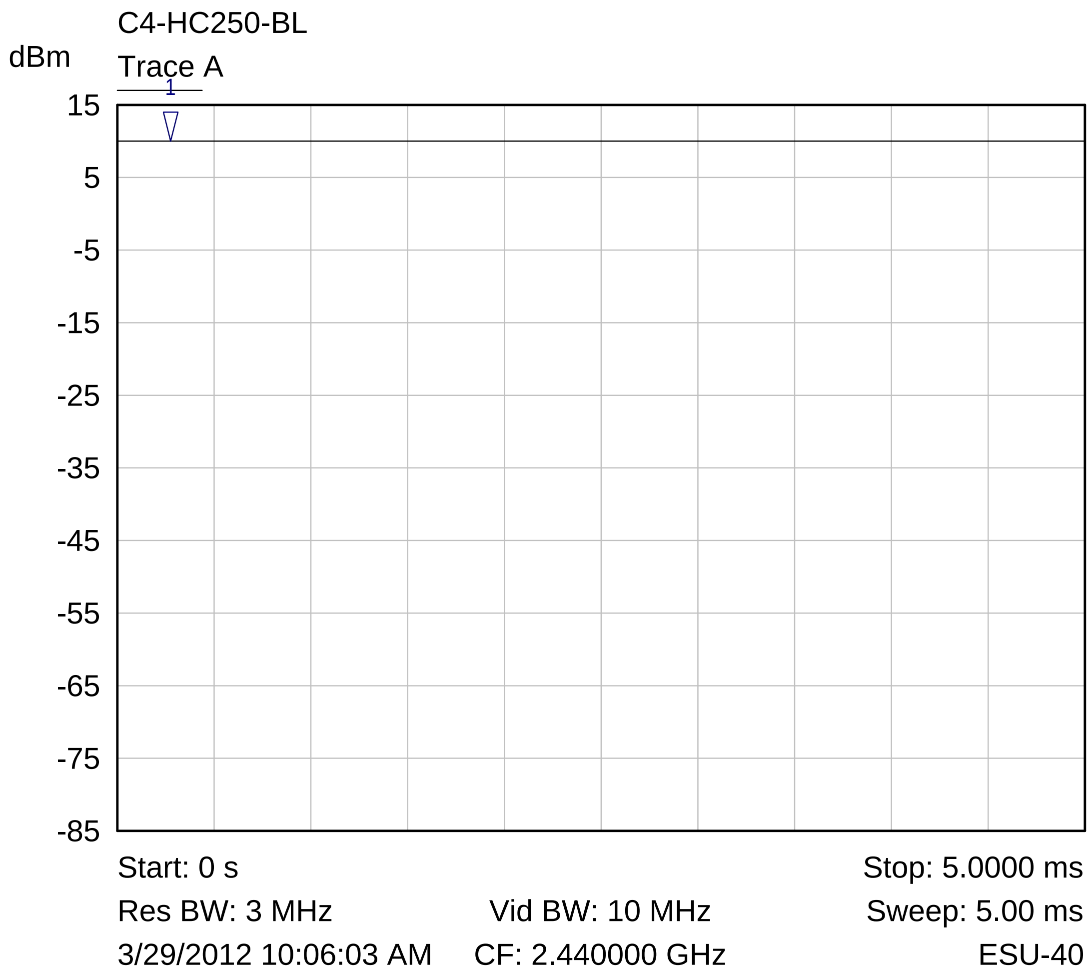
In the configuration tested, the RF peak output power was less than 1 Watt; therefore, the EUT complied with the requirements of the specification (see spectrum analyzer plots below).

Lower Channel



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	525.0000 us	10.71 dBm	

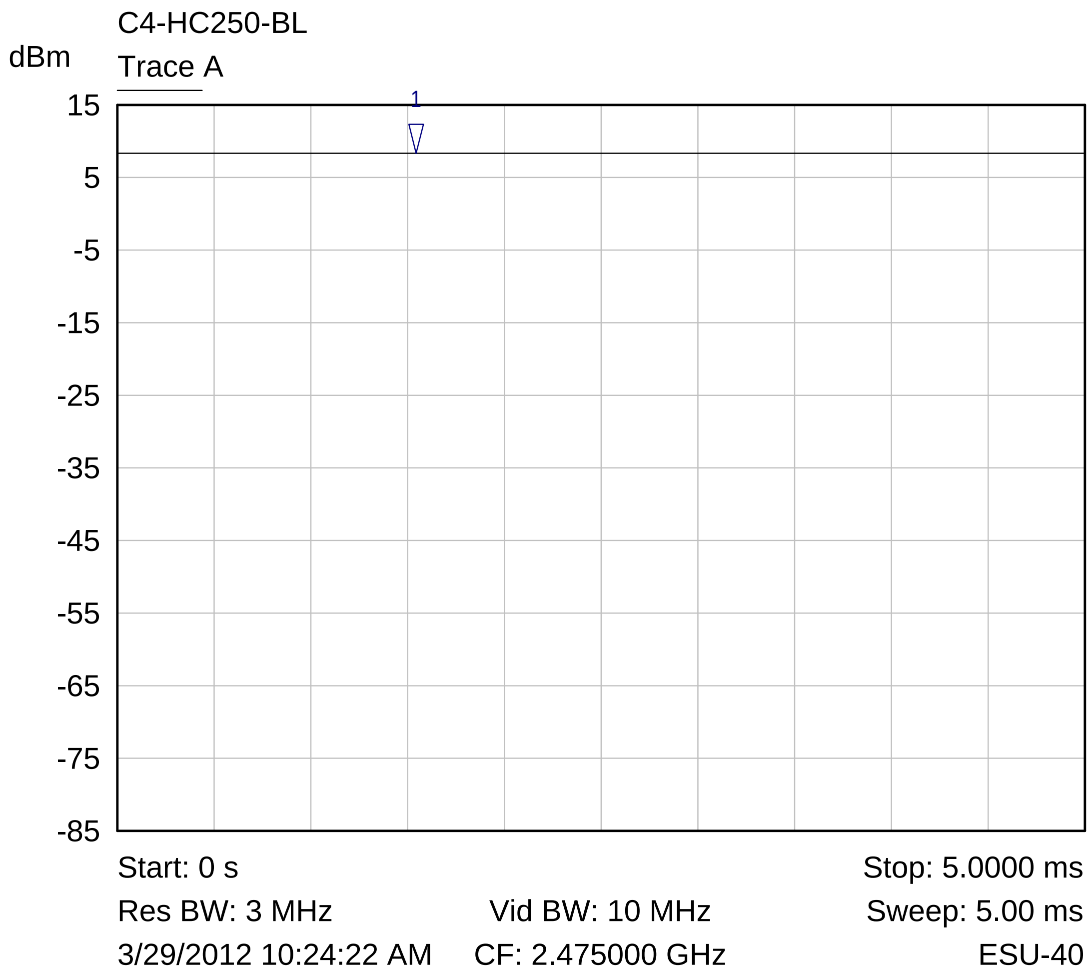
Middle Channel



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	275.0000 us	10.07 dBm	

Trace A output power

Upper Channel



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	1.5450 ms	8.38 dBm	

Trace A output power

7.2.5 §15.247(c) Spurious Emissions

7.2.5.1 Conducted Spurious Emissions

The frequency range from 150 kHz 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 7.6 dBm; therefore, the criteria is 7.6 – 20.0 = -12.4 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	-52.1	-12.4
7215.0	-66.7	-12.4
9620.0	-67.1	-12.4
12025.0	-65.9	-12.4
14430.0	-65.3	-12.4
16835.0	-66.4	-12.4
19240.0	-65.8	-12.4
21645.0	-65.6	-12.4
24050.0	-65.0	-12.4

Transmitting on the Middle Channel (2.440 GHz)

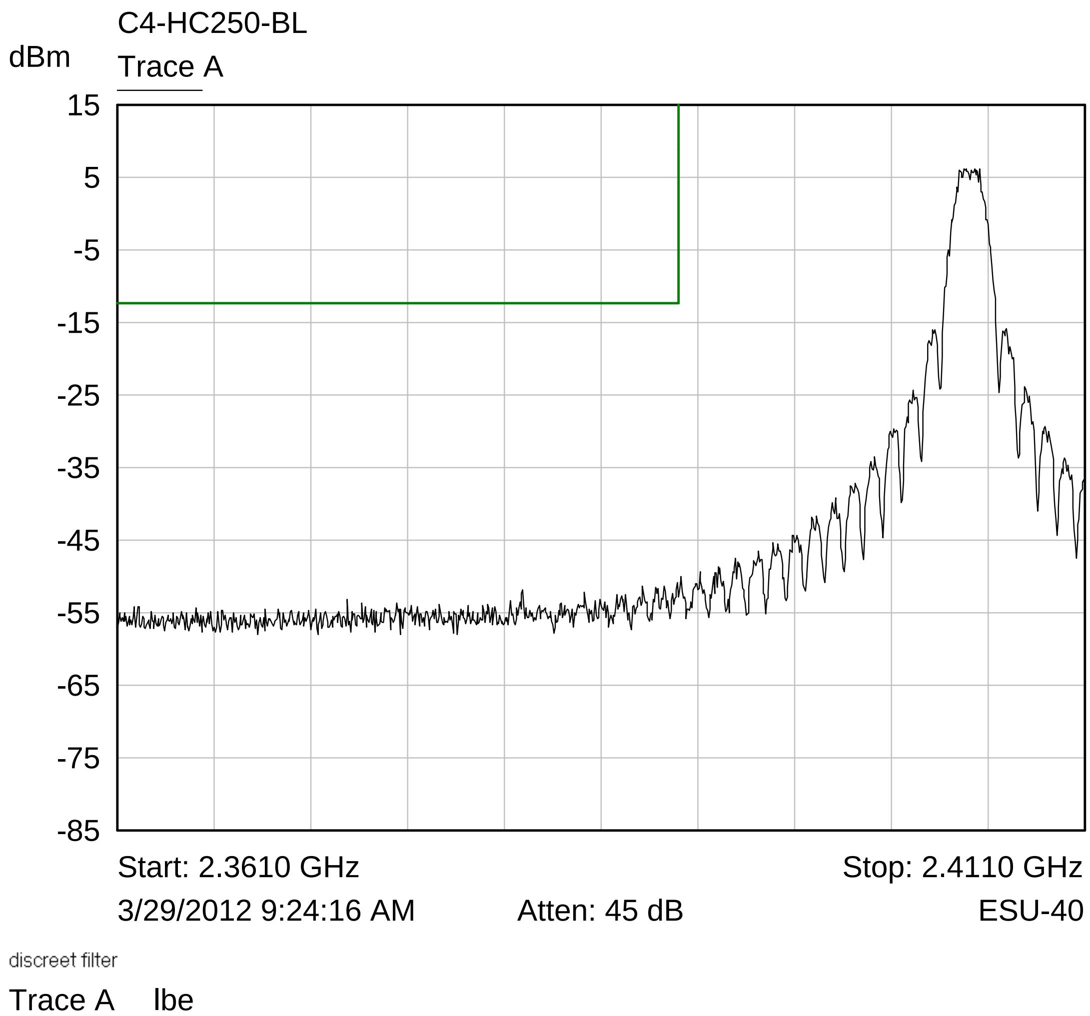
Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4880.0	-50.3	-12.4
7320.0	-65.8	-12.4
9760.0	-65.4	-12.4
12200.0	-64.0	-12.4

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
14640.0	-62.9	-12.4
17080.0	-68.4	-12.4
19520.0	-66.3	-12.4
21960.0	-66.5	-12.4
24400.0	-65.6	-12.4

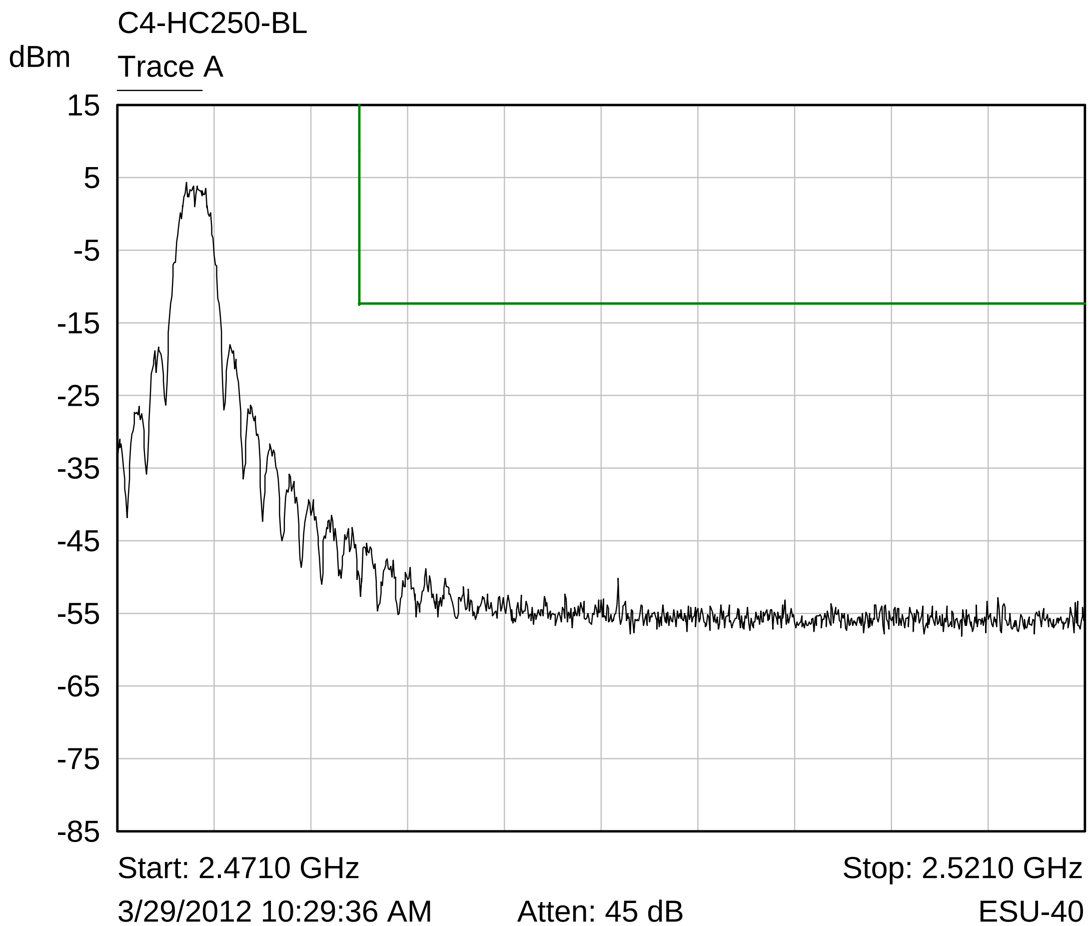
Transmitting on the Highest Channel (2.475 GHz)

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4950.0	-62.2	-12.4
7425.0	-68.3	-12.4
9900.0	-67.6	-12.4
12375.0	-65.5	-12.4
14850.0	-65.4	-12.4
17325.0	-64.5	-12.4
19800.0	-64.6	-12.4
22275.0	-64.9	-12.4
24750.0	-63.1	-12.4

Lower Band Edge



Upper Band Edge



discreet filter

Trace A ube

7.2.5.2 Radiated Emissions in the Restricted Bands of §15.205

The frequency range from 150 kHz 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	25.1	37.7	0.0	62.8	74.0	-11.2
4810.0	Average	Vertical	19.3	37.7	-7.5	49.5	54.0	-4.5
4810.0	Peak	Horizontal	21.2	37.7	0.0	58.9	74.0	-15.1
4810.0	Average	Horizontal	15.9	37.7	-7.5	46.1	54.0	-7.9
7215.0	Peak	Vertical	24.2	42.1	0.0	66.3	74.0	-7.7
7215.0	Average	Vertical	17.7	42.1	-7.5	52.3	54.0	-1.7
7215.0	Peak	Horizontal	18.3	42.1	0.0	60.4	74.0	-13.6
7215.0	Average	Horizontal	12.3	42.1	-7.5	46.9	54.0	-7.1
12025.0	Peak	Vertical	14.3	47.2	0.0	61.5	74.0	-12.5
12025.0	Average	Vertical	8.3	47.2	-7.5	48.0	54.0	-6.0
12025.0	Peak	Horizontal	9.5	47.2	0.0	56.7	74.0	-17.3

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Averaging Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
12025.0	Average	Horizontal	2.9	47.2	-7.5	42.6	54.0	-11.4
14430.0	Peak	Vertical	5.4	50.8	0.0	56.2	74.0	-17.8
14430.0	Average	Vertical	-2.4	50.8	-7.5	40.9	54.0	-13.1
14430.0	Peak	Horizontal	1.3	50.8	0.0	52.1	74.0	-21.9
14430.0	Average	Horizontal	-8.6	50.8	-7.5	34.7	54.0	-19.3

Transmitting at the Middle Frequency (2.440 GHz)

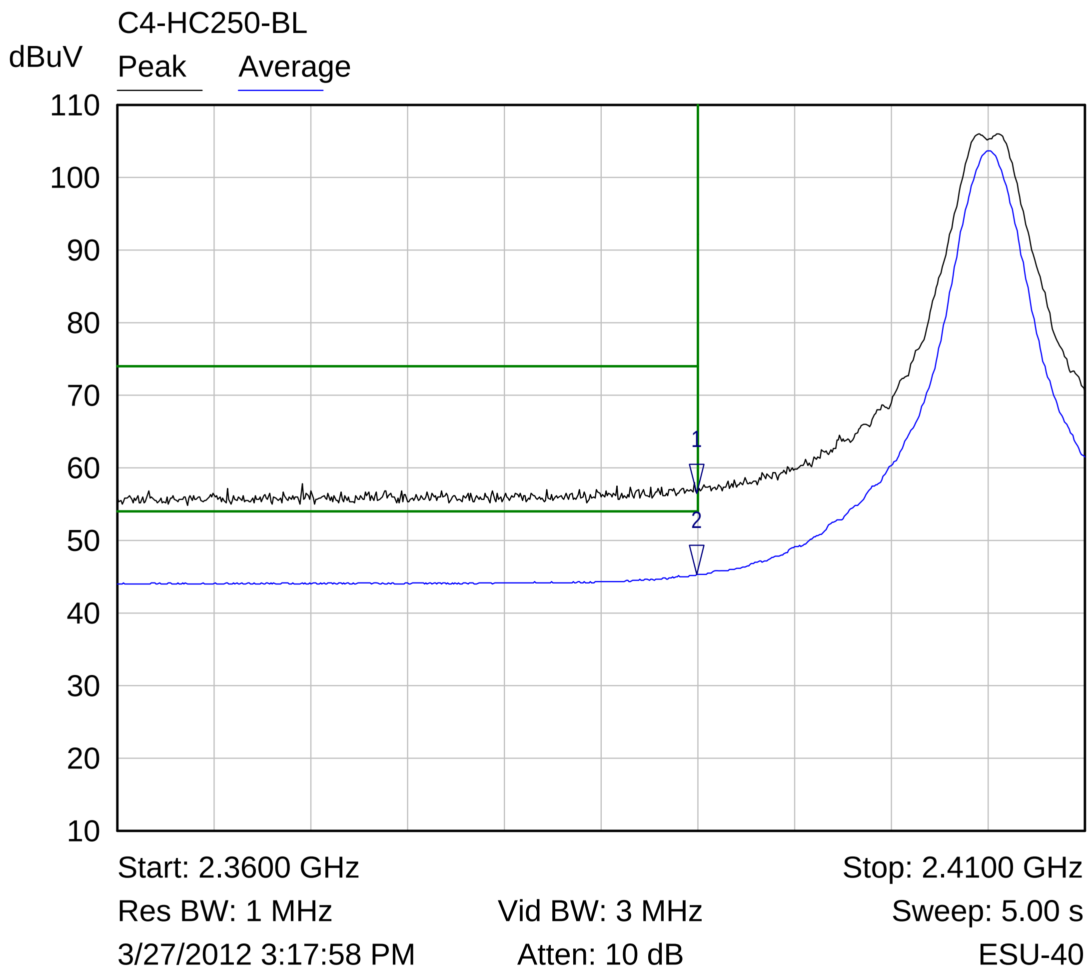
Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Averaging Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4880.0	Peak	Vertical	21.7	37.9	0.0	59.6	74.0	-14.4
4880.0	Average	Vertical	16.6	37.8	-7.5	46.9	54.0	-7.1
4880.0	Peak	Horizontal	17.9	37.8	0.0	55.7	74.0	-18.3
4880.0	Average	Horizontal	12.7	37.8	-7.5	43.0	54.0	-11.0
7320.0	Peak	Vertical	23.4	41.7	0.0	65.1	74.0	-8.9
7320.0	Average	Vertical	18.0	41.7	-7.5	52.2	54.0	-1.8
7320.0	Peak	Horizontal	18.5	41.7	0.0	60.2	74.0	-13.8
7320.0	Average	Horizontal	11.8	41.7	-7.5	46.0	54.0	-8.0
12200.0	Peak	Vertical	14.3	47.1	0.0	61.4	74.0	-12.6
12200.0	Average	Vertical	8.2	47.1	-7.5	47.8	54.0	-6.2
12200.0	Peak	Horizontal	8.3	47.1	0.0	55.4	74.0	-18.6
12200.0	Average	Horizontal	0.4	47.1	-7.5	40.0	54.0	-14.0
14640.0	Peak	Vertical	5.2	50.5	0.0	55.7	74.0	-18.3
14640.0	Average	Vertical	-2.1	50.5	-7.5	40.9	54.0	-13.1
14640.0	Peak	Horizontal	1.1	50.5	0.0	51.6	74.0	-22.4
14640.0	Average	Horizontal	-9.6	50.5	-7.5	33.4	54.0	-20.6

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)
4950.0	Peak	Vertical	21.2	38.0	0.0	59.2	74.0	-14.8
4950.0	Average	Vertical	16.1	38.0	-7.5	46.6	54.0	-7.4
4950.0	Peak	Horizontal	17.4	38.0	0.0	55.4	74.0	-18.6
4950.0	Average	Horizontal	12.0	38.0	-7.5	42.5	54.0	-11.5
7425.0	Peak	Vertical	18.9	42.6	0.0	61.5	74.0	-12.5
7425.0	Average	Vertical	13.1	42.6	-7.5	48.2	54.0	-5.8
7425.0	Peak	Horizontal	16.4	42.6	0.0	59.0	74.0	-15.0
7425.0	Average	Horizontal	10.3	42.6	-7.5	45.4	54.0	-8.6
12375.0	Peak	Vertical	13.4	47.0	0.0	60.4	74.0	-13.6
12375.0	Average	Vertical	7.4	47.0	-7.5	46.9	54.0	-7.1
12375.0	Peak	Horizontal	6.6	47.0	0.0	53.6	74.0	-20.4
12375.0	Average	Horizontal	-1.2	47.0	-7.5	38.3	54.0	-15.7
14850.0	Peak	Vertical	4.4	49.8	0.0	54.2	74.0	-19.8
14850.0	Average	Vertical	-3.7	49.8	-7.5	38.6	54.0	-15.4
14850.0	Peak	Horizontal	2.6	49.8	0.0	52.4	74.0	-21.6
14850.0	Average	Horizontal	-6.8	49.8	-7.5	35.5	54.0	-18.5

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.

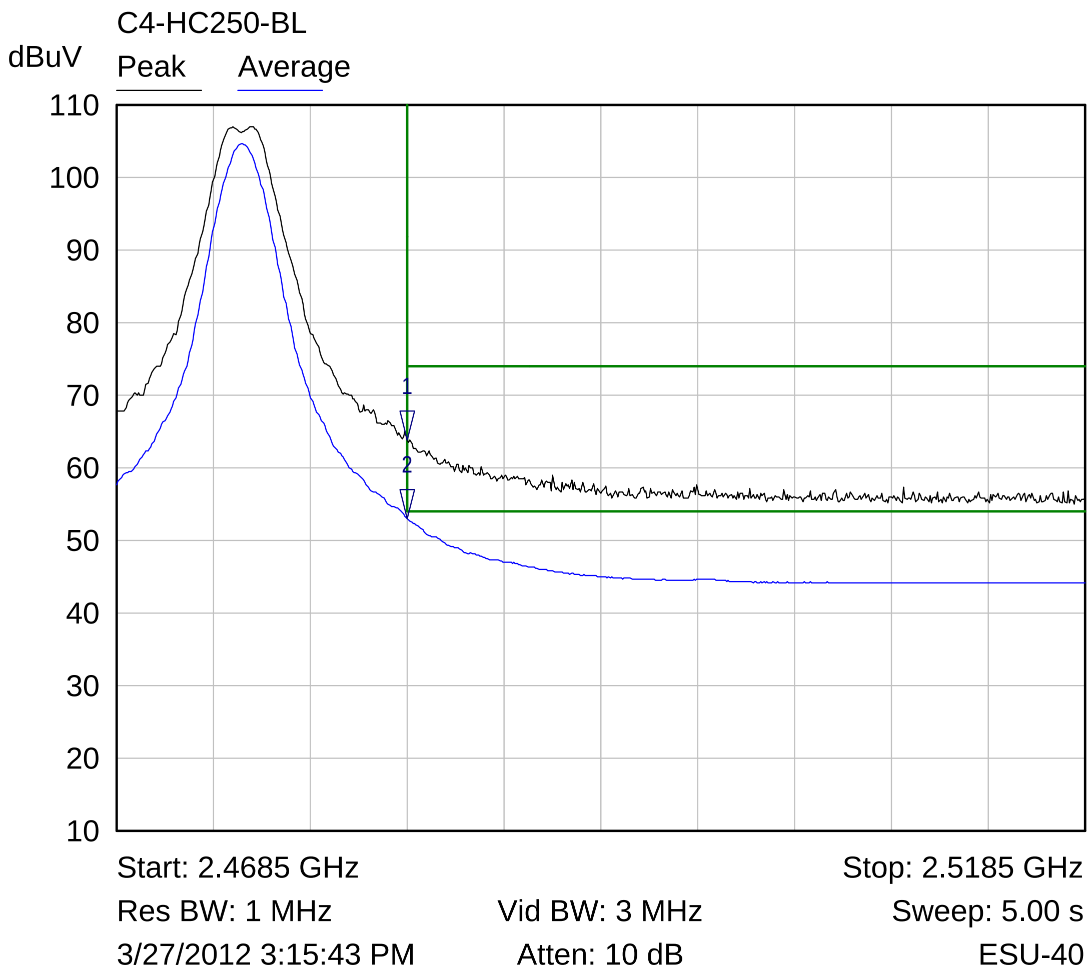
Lower Band Edge



Mkr	Trace	X-Axis	Value	Notes
1 ∇	Peak	2.3900 GHz	56.54 dBuV	
2 ∇	Average	2.3900 GHz	45.30 dBuV	

Peak Zigbee at +3/20, discreet filter

Upper Band Edge



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Peak	2.4835 GHz	63.84 dBuV	
2 ▽	Average	2.4835 GHz	53.04 dBuV	

Peak Zigbee at +3/20, discreet filter

7.2.6 §15.247(d) Peak Power Spectral Density

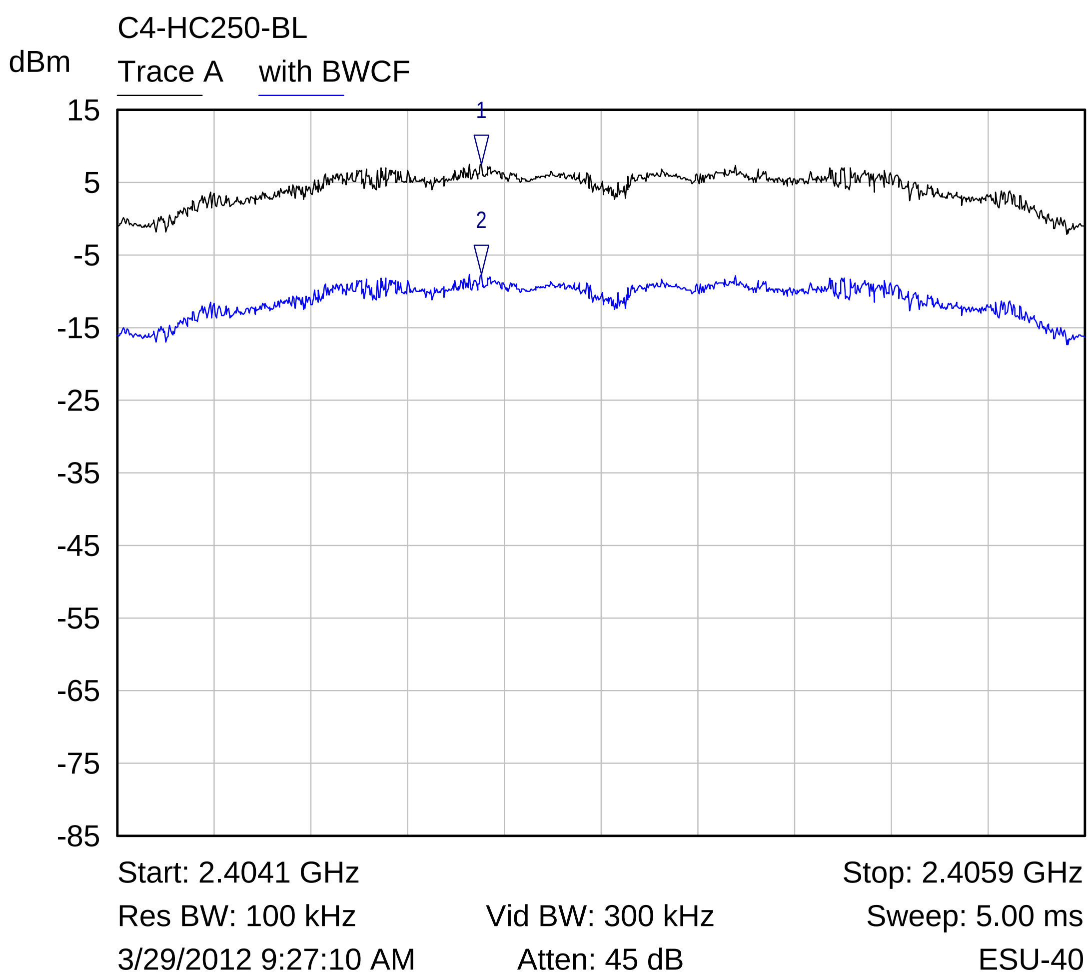
The peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. Measurements were made using 558074 D01 DTS Measurement Guidance v01 5.3.1.
The plots are shown below and the results of this testing are summarized in the table below.

Frequency (MHz)	Measurement (dBm)	Criteria (dBm)	Margin (dBm)
2405	-7.65	8.0	-15.75
2440	-8.23	8.0	-16.23
2475	-10.06	8.0	-18.06

RESULT

The EUT complies with the specification.

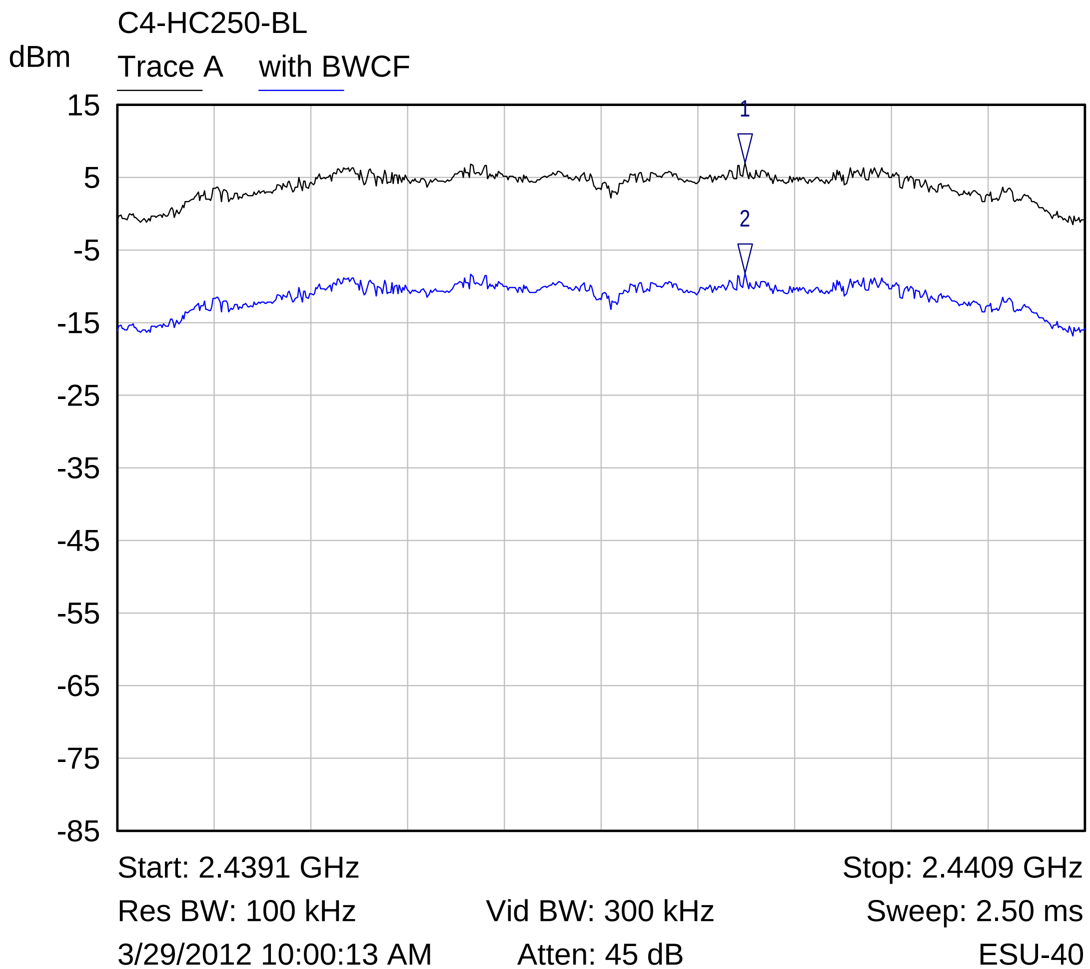
Lower Channel



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4048 GHz	7.55 dBm	
2 ▽	with BWCF	2.4048 GHz	-7.65 dBm	

discreet filter

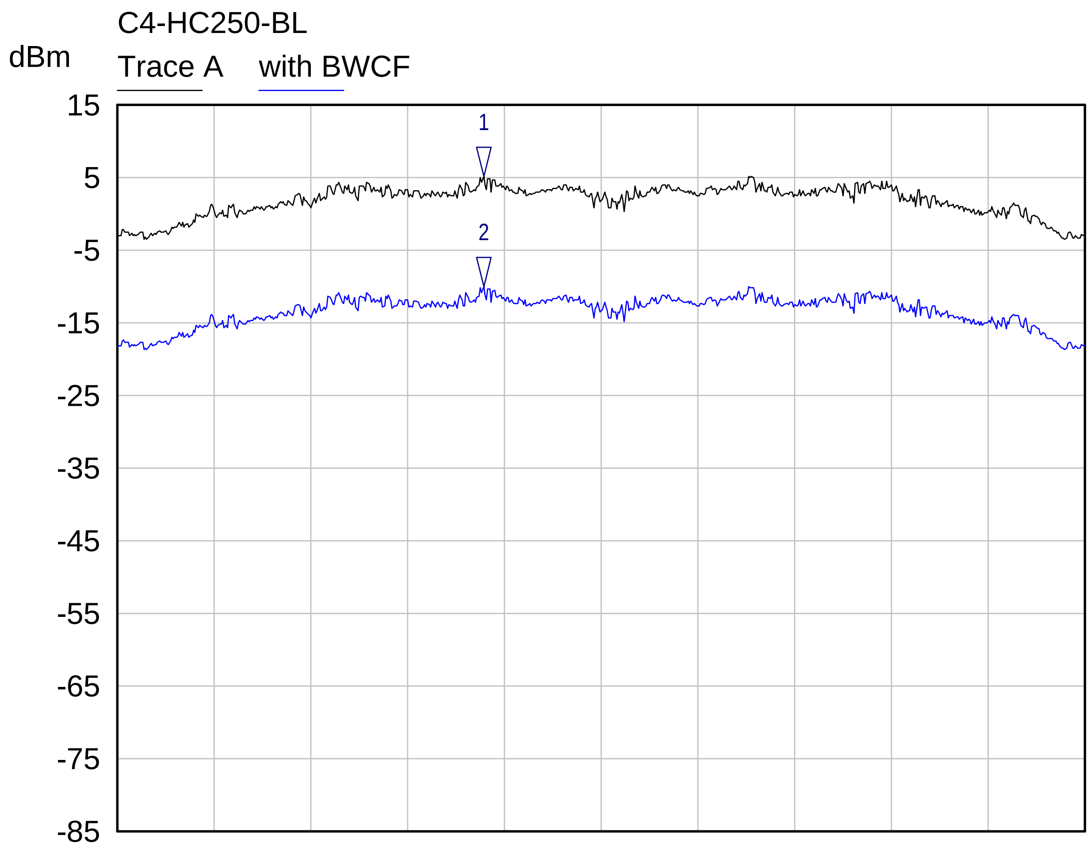
Middle Channel



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4403 GHz	6.97 dBm	
2 ▽	with BWCF	2.4403 GHz	-8.23 dBm	

discreet filter

Upper Channel



Start: 2.4741 GHz | Stop: 2.4759 GHz
Res BW: 100 kHz | Vid BW: 300 kHz | Sweep: 2.50 ms
3/29/2012 10:28:10 AM | Atten: 45 dB | ESU-40

Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4748 GHz	5.14 dBm	
2 ▽	with BWCF	2.4748 GHz	-10.06 dBm	

discreet filter

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 μH) 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.

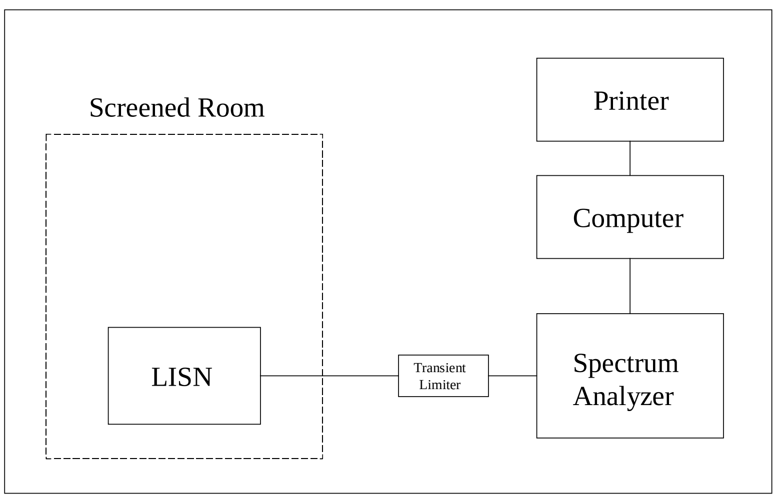
For AC mains port testing the desktop EUT are placed on a non-conducting table at least 0.8 meters from the metallic floor. The equipment is placed a minimum of 40 cm from all walls. Floor standing equipment is placed directly on the earth grounded floor.

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

Type of Equipment	Manufacturer	Model Number	Serial Number	Date of Last Calibration
Quasi-Peak Detector	Hewlett Packard	85650A	2043A00137	01/18/2012
LISN	EMCO	3825/2	9305-2099	03/12/2012
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

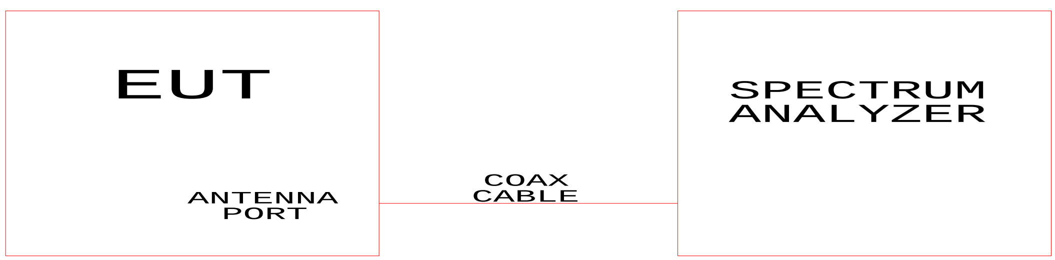


A1.2 Direct Connection at the Antenna Port Tests

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.

A loop antenna was used to measure emissions below 30 MHz. Emission readings more than 20 dB below the limit at any frequency may not be listed in the reported data. For frequencies between 9 kHz and 30 MHz, or the lowest frequency generated or used in the device greater than 9 kHz, and less than 30 MHz, the spectrum analyzer resolution bandwidth was set to 9 kHz and the video bandwidth was set to 30 kHz. For average measurements, the spectrum analyzer average detector was used.

For frequencies above 30 MHz, 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 measurements 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.

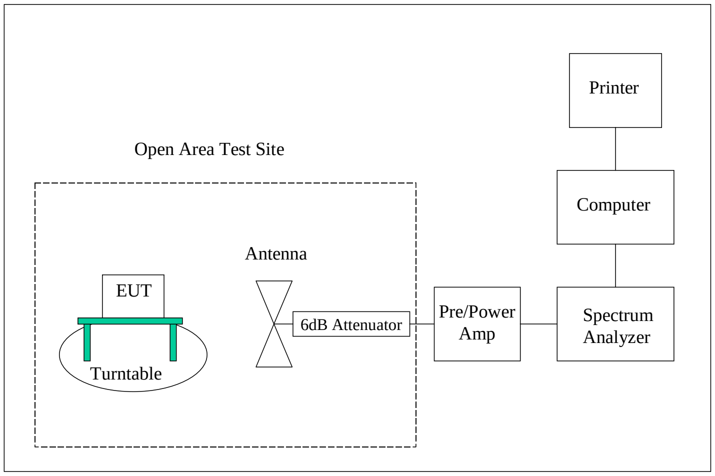
Desktop intentional radiators are measured on a non-conducting table 80 centimeters above the ground plane. The table is placed on a turntable which is level with the ground plane. The turntable has slip rings, which supply AC power to the intentional radiator. For equipment normally placed on floors,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

Type of Equipment	Manufacturer	Model Number	Serial Number	Date of Last Calibration

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
Loop Antenna	EMCO	6502	2011	03/11/2011
Biconilog Antenna	EMCO	3142	9601-1009	04/21/2011
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



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

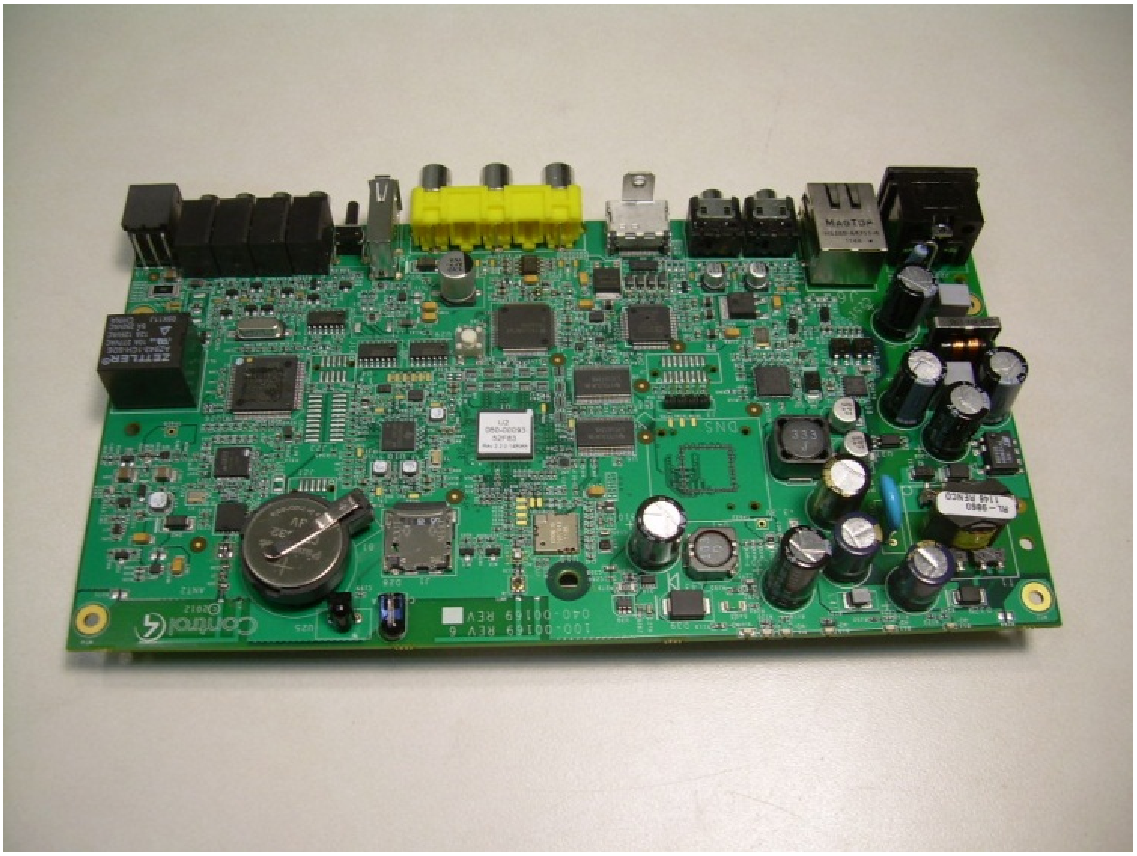
Photograph 4 – Back View Conducted Disturbance Worst Case Configuration

Photograph 5 – Front View of the EUT

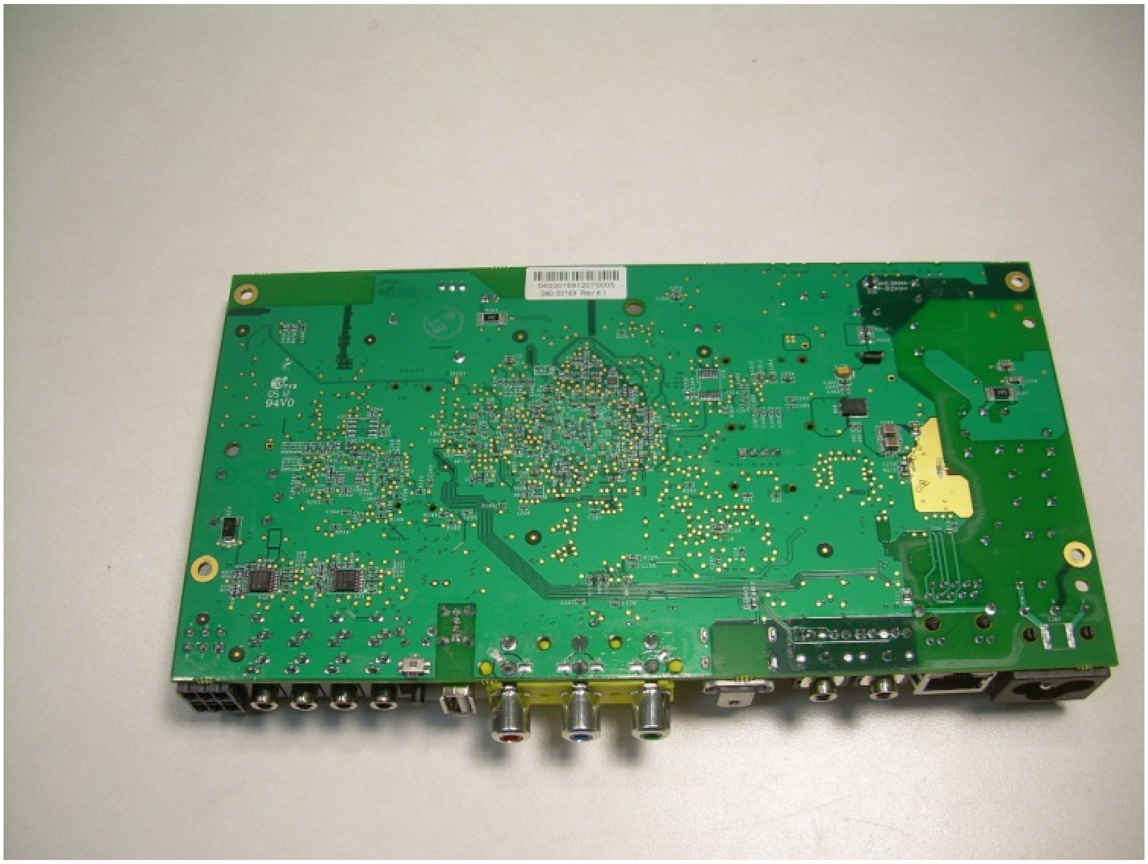
Photograph 6 – Back View of the EUT

Photograph 7 – Internal View Front of the EUT

Photograph 8 – View of the Component Side of the PCB



Photograph 9 – View of the Trace Side of the PCB



APPENDIX 3 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 Pramble, 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 (total)	**0.01012**	**(0.004256 + 0.005864)**	**MAC TX Duty Cycle (On/Total) = 42.06**