COMMUNICATION CERTIFICATION LABORATORY

1940 West Alexander Street
Salt Lake City, UT 84119
801-972-6146

Test Report

Certification

TEST OF: LC-AVMHTC1

FCC ID: R33LCAVMHTC101

To FCC PART 15, Subpart C
(15.203, 15.207, 15.247)

Test Report Serial No: 73-8336

Applicant:

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

Dates of Test: June 12, 2006

Issue Date: June 13, 2006

Equipment Receipt Date: June 12, 2006

Accredited Testing Laboratory By:

NVLAP Lab Code 100272-0

CERTIFICATION OF ENGINEERING REPORT

This report has been prepared by Communication Certification Laboratory to document compliance of the device described below with the requirements of Federal Communications Commission (FCC) Part 15, Subpart C, Sections 15.203, 15.207, and 15.247. 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: Johnson Controls
- Model Number: LC-AVMHTC1
- FCC ID Number: R33LCAVMHTC101

On this 13th day of June 2006, I, individually, and for Communication Certification Laboratory, 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 Communication Certification Laboratory 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.

COMMUNICATION CERTIFICATION LABORATORY

Norman P Hansen

Tested by: Norman P. Hansen
EMC Technician

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SECTION 1.0 CLIENT INFORMATION

1.1 Applicant:

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

Contact Name: Jon Nelson
Title: Hardware Engineer

1.2 Manufacturer:

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

Contact Name: Jon Nelson
Title: Hardware Engineer

SECTION 2.0 EQUIPMENT UNDER TEST (EUT)

2.1 Identification of EUT:

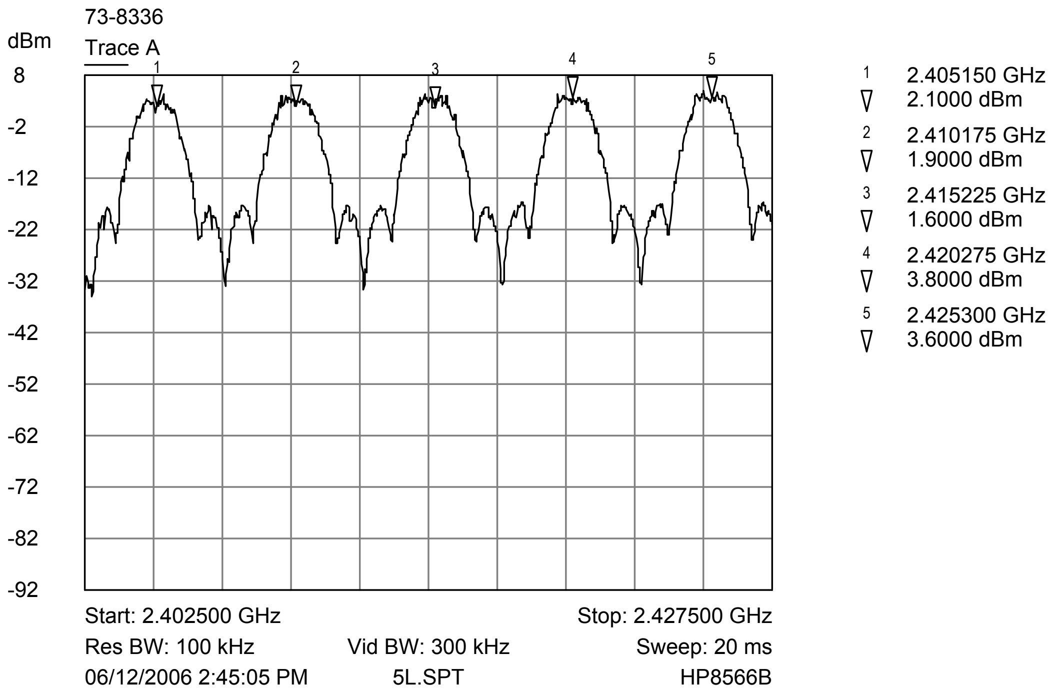
Brand Name:	Johnson Controls
Model Name or Number:	LC-AVMHTC1
Serial Number:	None
Options Fitted:	N/A
Country of Manufacture:	U.S.A., India, China

2.2 Description of EUT:

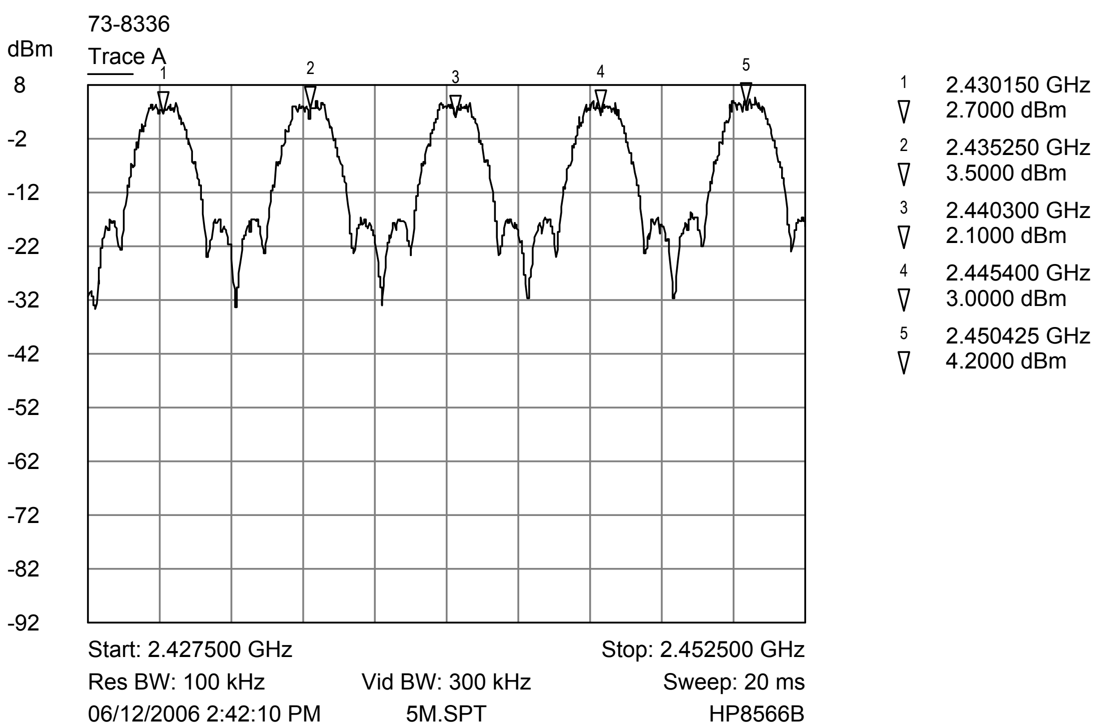
The LC-AVMHTC1 is a Home Theater Controller. It is designed to control Audio and Video devices and has the ability to also control other equipment manufactured by Control4 to control lighting and temperature. Six IR out ports, a Composite Video port, S-video port, two left and right audio in ports, a left and right audio out port, and a video sense port are provided for connection to other audio and video equipment. An internal USB port had a Simple Tech 256 MB memory module installed. An external USB port is also provided. Connection to a network or the Internet is via an Ethernet port. A Contact/Relay/Serial port is provided for serial communications, contact sense, and relay control. An 802.15.4 ZigBee transceiver is included in the device for mesh networking and control purposes. The Zigbee radio uses either an internal etched antenna on the PCB or an external dipole antenna. The antenna selection is controlled by an internal switch and software. The external dipole antenna with the highest gain, 3.2 dBi, was used for testing, as was the internal etched antenna.

This report covers the 802.15.4 ZigBee transceiver and testing was performed to FCC Part 15 Subpart C. The digital and control circuitry testing is to be covered in a separate report.

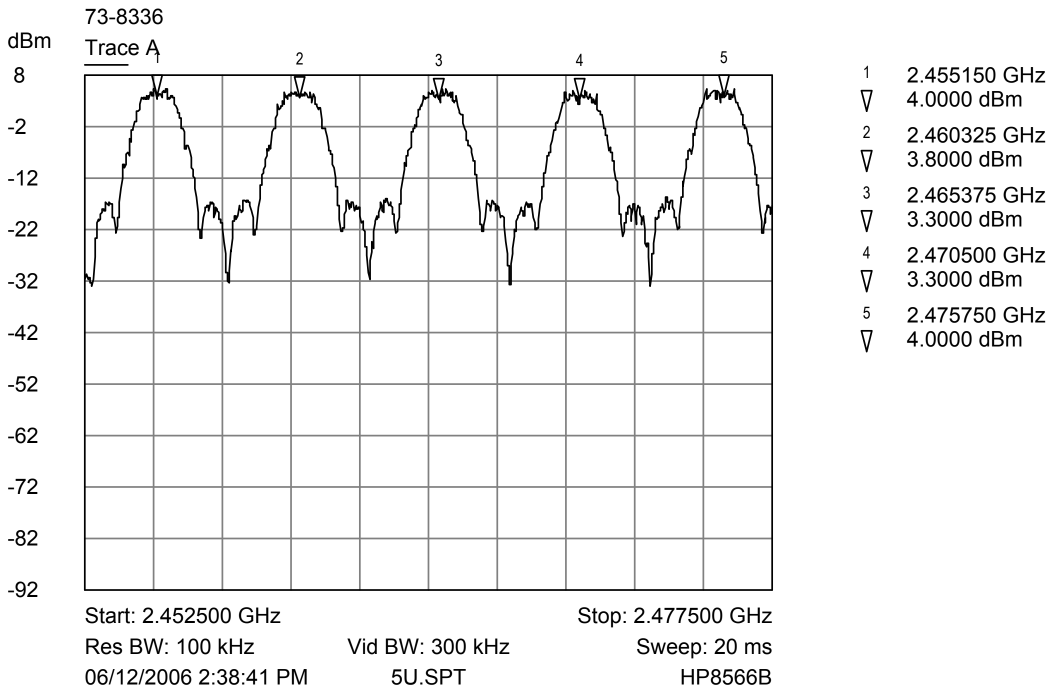
The 802.15.4 transceiver uses 15 channels in the 2400 to 2483.5 MHz band. The individual channels are shown in the following plots.



Trace A Lower 5 channels



Trace A Middle 5 channels



Trace A Upper 5 channel

2.3 EUT and Support Equipment:

The FCC ID numbers for all the EUT and support equipment used during the test (including inserted cards) are listed below:

Brand Name Model Number Serial No.	FCC ID Number	Description	Name of Interface Ports / Interface Cables
BN: Johnson Controls MN: LC-AVMHTC1 (Note 1)	R33LCAVMHTC101	Home Theater Controller	See Section 2.4
BN: Simple Tech MN: SLUFD2256U	DoC	USB Memory Module	Direct connection to internal USB port on main PCB of the EUT (Note 2)

Brand Name Model Number Serial No.	FCC ID Number	Description	Name of Interface Ports / Interface Cables
BN: Allied Telesyn International MN: AT-MC13	Verification	Copper to Fiber Ethernet Adapter	Ethernet/Cat5 with RJ45 connectors (Note 2)

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
Video Sense In	2	RCA cables/1 meter
Video Sense Out	2	RCA cables/1 meter
Composite Video	1	RCA cable/1 meters
Svideo	1	Svideo cable/1 meter
L & R Audio In	1	RCA cable/1 meters
L & R Audio Out	2	RCA cables/1 meter
Ethernet	1	Cat5 cable w/RJ45 connectors/8 meters
IR Out	6	Cable w/mono, mini jack connectors/1 meter
USB	2	USB module directly plugged into the internal port and USB cable at 1.5 meters connected to external USB port
RS485/FC Bus/Relay	1	Cat5 cable (7 conductors used) and 2 other unshielded conductors/1 meter

Name of Ports	No. of Ports Fitted to EUT	Cable Descriptions/Length
Antenna	1	Dipole antenna with reverse SMA connector

2.5 Modification Incorporated/Special Accessories on EUT:

The following modifications were required to comply with the specification.

1. The transmit power was set to –b from a default of –2 when using an external antenna. –2 will still be used for the internal etched PCB antenna. Firmware will be used to set the transmit level depending on which antenna is in use and the level setting will not be user adjustable.

Signature: ______________________________

Typed Name: Jon Nelson

Title: Hardware Engineer

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. 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 which use fewer than 75 hopping frequencies may employ intelligent hopping techniques to avoid interference to other transmissions. 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 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

(4) Except as shown in paragraphs (b)(4)(i), (ii), and (iii) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the peak output 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.

(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.

(5) 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.

(c) 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. 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)).

(d) For digitally modulated systems, 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.

(e) [Reserved]

(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. 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 line conducted and radiated emissions testing was performed according to the procedures in ANSI C63.4 (2003). Testing was performed at CCL's Wanship open area test site #2, located at 550 West Wanship Road, Wanship, UT. This site has been fully described in a report submitted to the FCC, and was accepted in a letter dated August 11, 2003 (90504).

CCL participates in the National Voluntary Laboratory Accreditation Program (NVLAP) and has been accepted under NVLAP Lab Code:100272-0, which is effective until September 30, 2005.

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

4.2 Operating Modes:

The transmitter was in a constant transmit mode at the desired frequency.

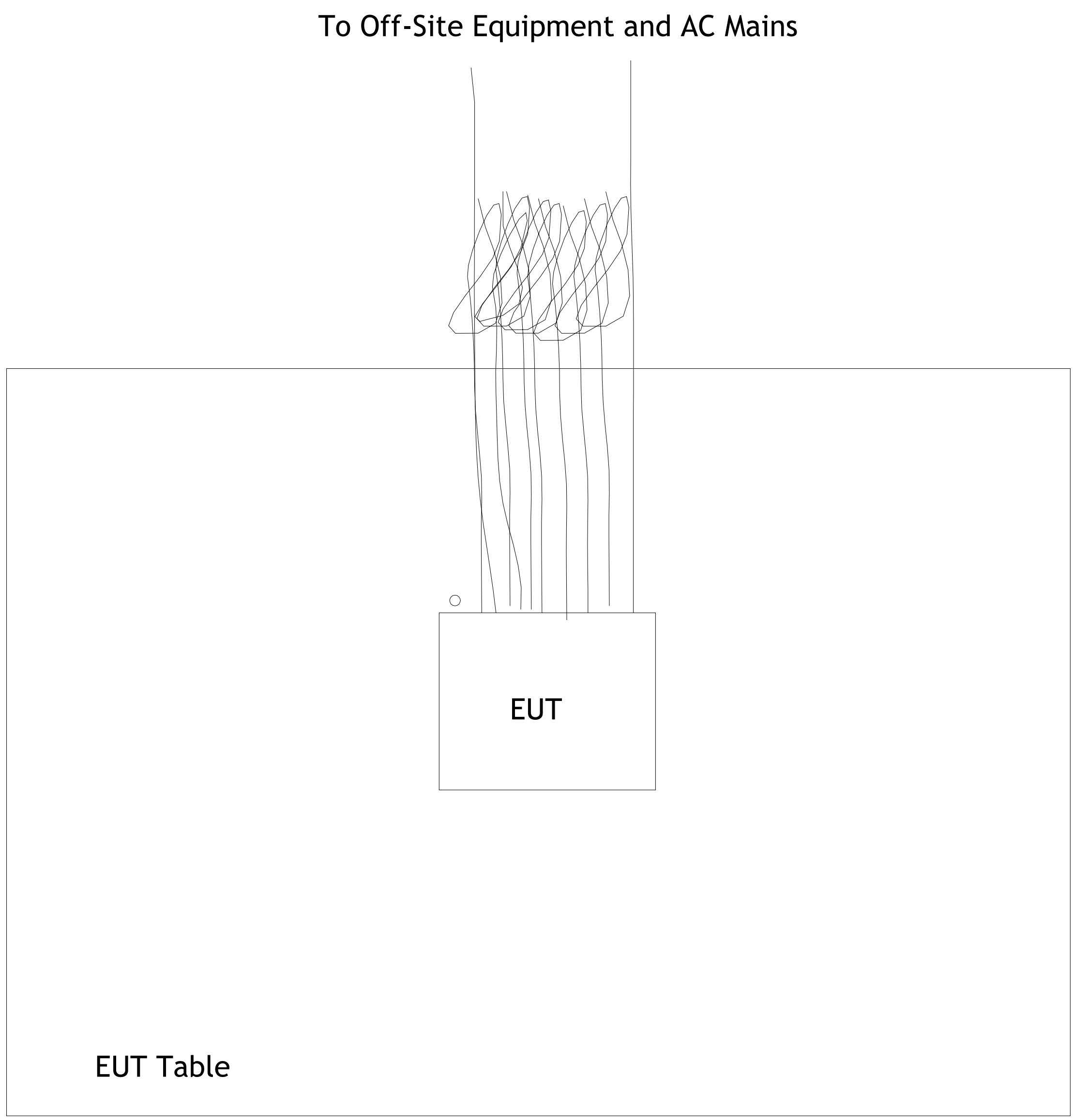
4.3 EUT Exercise Software:

Internal firmware was used to exercise the transmitter.

4.4 Configuration & Peripherals:

The LC-AVMHTC1 was placed on the table and connected to the support equipment listed in Section 2.3 via each port listed in Section 2.4. Shown in Section 4.5 is a block diagram of the test configuration.

4.5 Block Diagram of Test Configuration:



SECTION 5.0 SUMMARY OF TEST RESULTS

5.1 FCC Part 15, Subpart C

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 EUT complied with the requirements of the specification.

SECTION 6.0 MEASUREMENTS, EXAMINATIONS AND DERIVED 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 antenna must be designed to ensure that no antenna other than the antenna supplied by the responsible party can be used with the device. The EUT complies with this requirement as the antenna is an etched portion of the PCB board, or if using the external antenna, a reverse SMA connector is used to attach the antenna.

6.2.2 §15.207 Conducted Disturbance at the AC Mains Ports

6.2.2.1 Conducted Disturbance at Mains Ports Data (Hot Lead)

Frequency MHz	Detector	Measured Level dBμV	Limit dBμV	Margin dB
0.18	Peak (Note 1)	43.3	54.5	-11.2
0.20	Peak (Note 1)	45.7	53.6	-7.9
0.26	Peak (Note 1)	36.6	51.4	-14.8
0.34	Peak (Note 1)	35.6	49.2	-13.6
0.40	Peak (Note 1)	34.8	47.9	-13.1
1.08	Peak (Note 1)	35.4	46.0	-10.6

Note 1: The reference detector used for the measurements was peak or quasi-peak and the data was compared to the average limit; therefore, the EUT was deemed to meet both the average and quasi-peak limits.

Note 2: The reference detector used for the measurements was quasi-peak and average and the data was compared to the respective limits.

Measurement Uncertainty

The measurement uncertainty (with a 95% confidence level) for this test was: ± 3.3 dB.

RESULT

The EUT complied with the specification limit by a margin of 7.9 dB.

6.2.2.2 Conducted Disturbance at Mains Ports Data (Neutral Lead)

Frequency MHz	Detector	Measured Level dBμV	Limit dBμV	Margin dB
0.19	Peak (Note 1)	50.1	53.9	-3.8
0.26	Peak (Note 1)	48.1	51.5	-3.4
0.33	Peak (Note 1)	43.1	49.6	-6.5
0.40	Peak (Note 1)	39.7	47.9	-8.2
0.52	Peak (Note 1)	38.3	46.0	-7.7
1.03	Peak (Note 1)	39.0	46.0	-7.0
1.09	Peak (Note 1)	38.8	46.0	-7.2

Note 1: The reference detector used for the measurements was peak or quasi-peak and the data was compared to the average limit; therefore, the EUT was deemed to meet both the average and quasi-peak limits.

Note 2: The reference detector used for the measurements was quasi-peak and average and the data was compared to the respective limits.

Measurement Uncertainty

The measurement uncertainty (with a 95% confidence level) for this test was: ± 3.3 dB.

RESULT

The EUT complied with the specification limit by a margin of 3.4 dB.

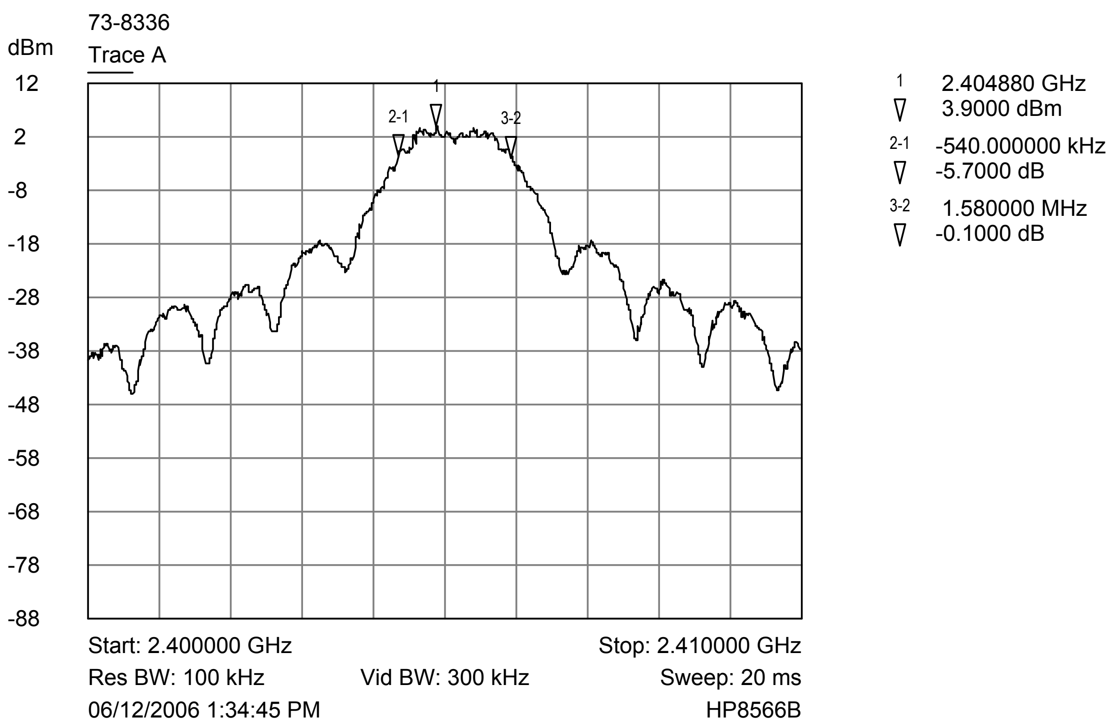
6.2.3 §15.247(a)(2) Emission Bandwidth

A diagram of the test configuration and the test equipment used is enclosed in Appendix 1.

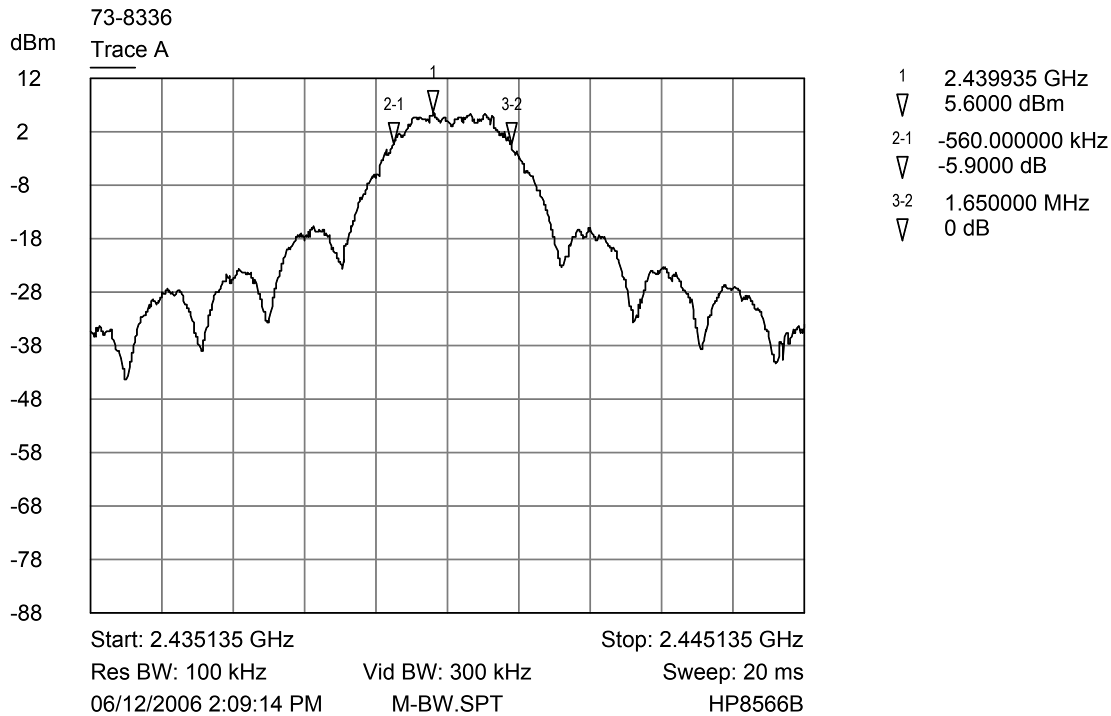
Frequency (MHz)	Emission 6dB Bandwidth (kHz)
2404.88	1580
2439.94	1650
2475.46	1590

RESULT

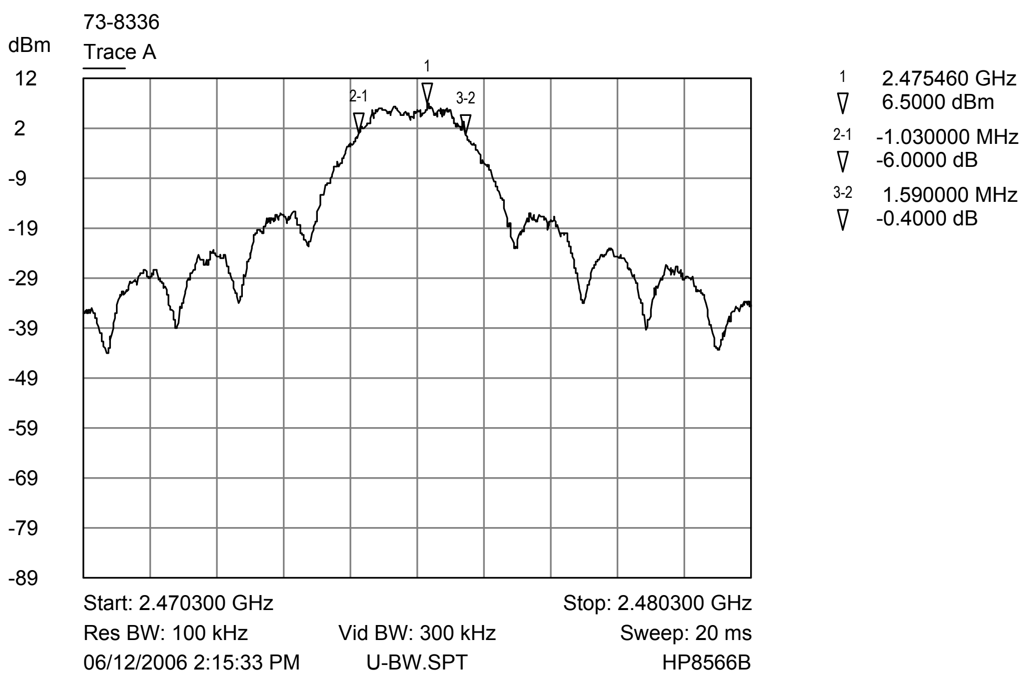
In the configuration tested, the 6 dB bandwidth was greater than 500 kHz; therefore, the EUT complied with the requirements of the specification (see spectrum analyzer plots below).



Trace A Lower channel bandwidth plot



Trace A Middle channel bandwidth plot



Trace A Upper channel bandwidth plot

6.2.4 §15.247(b)(3) Peak Output Power

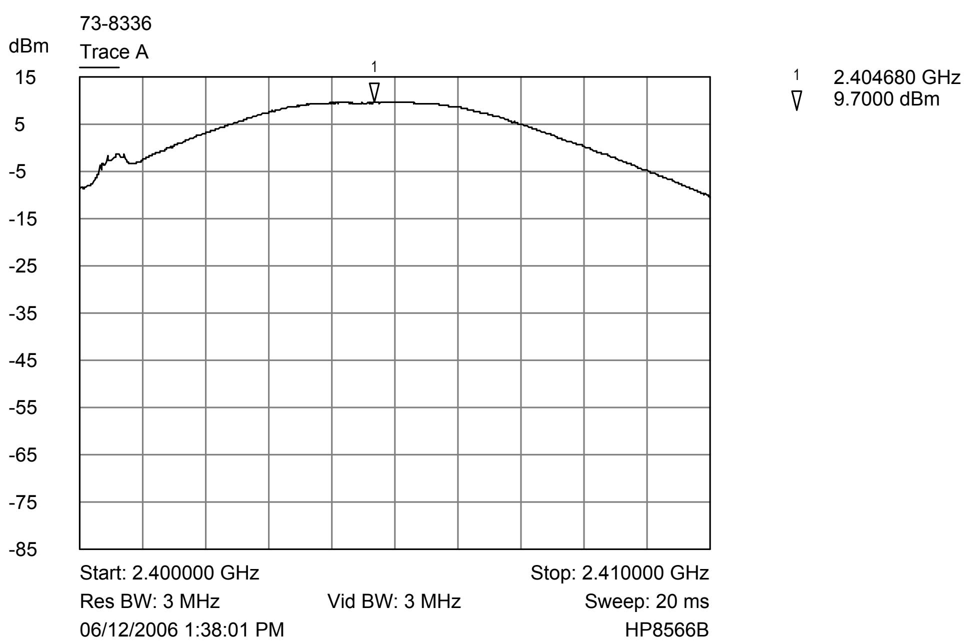
The maximum peak RF Conducted output power measured for this device was 11.75 mW or 10.7 dBm. The maximum directional gain of the antenna is less than 6 dBi; therefore, the maximum output power is not required to be reduced from the value measured.

A diagram of the test configuration and the test equipment used is enclosed in Appendix 1.

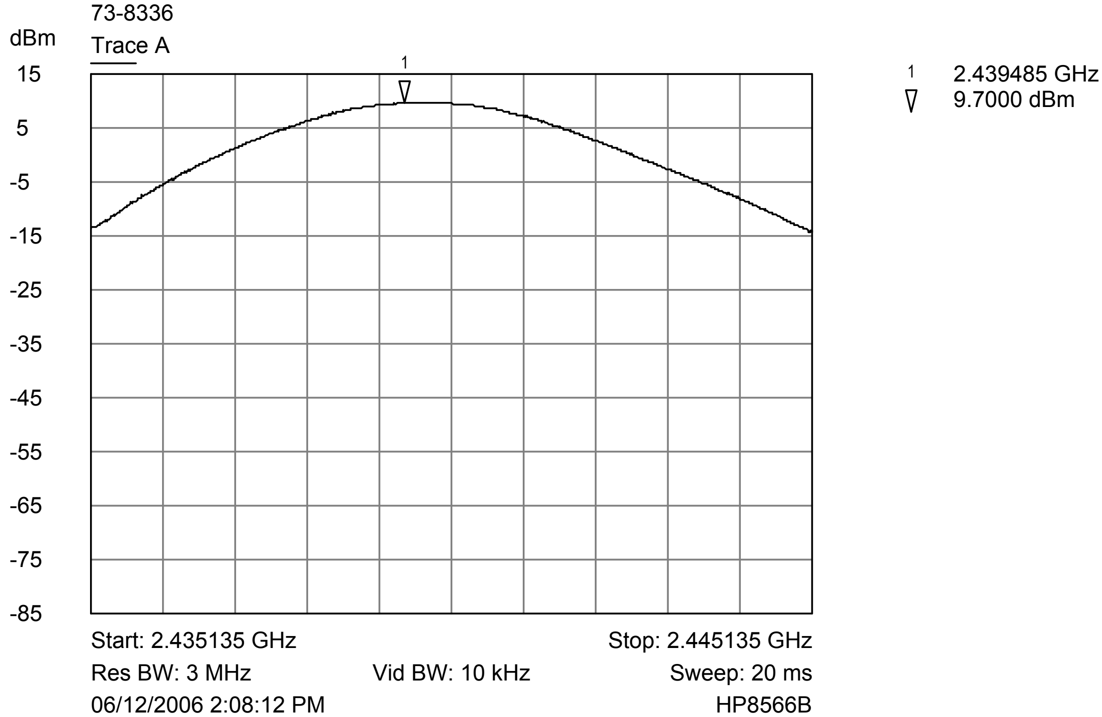
Frequency (MHz)	Measured Output Power (dBm)	Measured Output Power (mW)
2404.68	9.7	9.33
2439.49	9.7	9.33
2474.84	10.7	11.75

RESULT

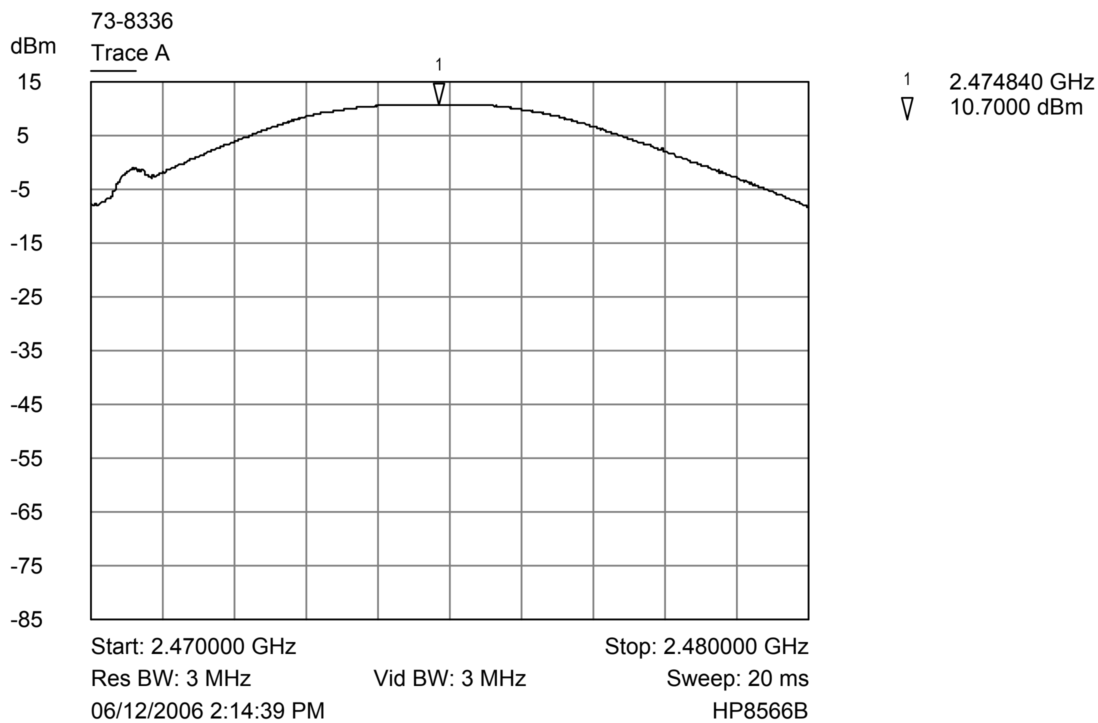
In the configuration tested, the RF peak output power was less than 1 Watt; therefore, the EUT complied with the requirements of the specification (see spectrum analyzer plots below).



Trace A Lower channel output power



Trace A Middle channel output power plot



Trace A Upper channel output power plot

6.2.5 §15.247(c) Spurious Emissions

6.2.5.1 Conducted Spurious Emissions

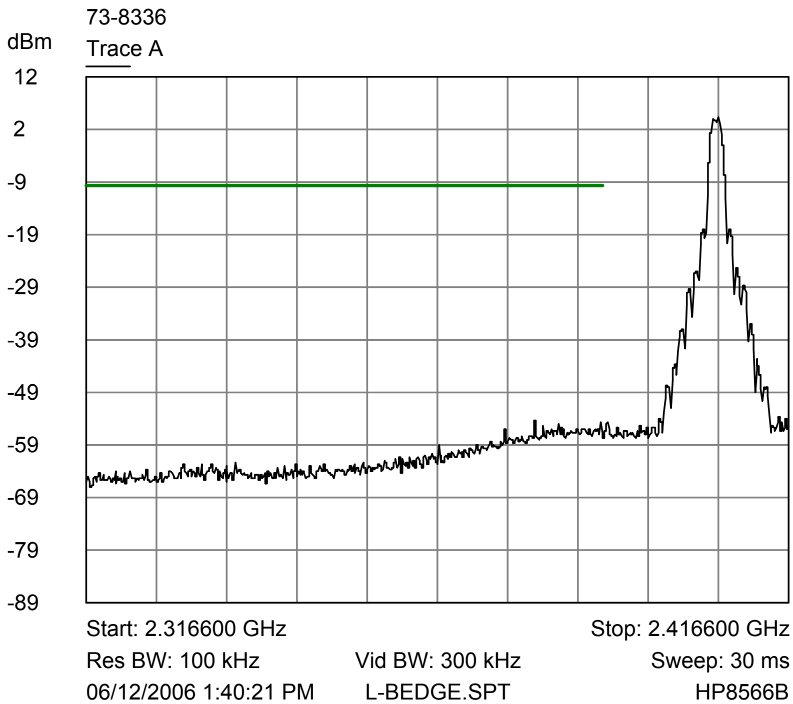
The frequency range from 10 MHz to the tenth harmonic of the highest fundamental frequency was investigated to measure any antenna-conducted emissions. Shown below are plots with the EUT tuned to the upper and lower channels. These demonstrate compliance with the provisions of this section at the band 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 10.7 dBm; therefore, the criteria is 10.7 – 20.0 = -9.3 dBm.

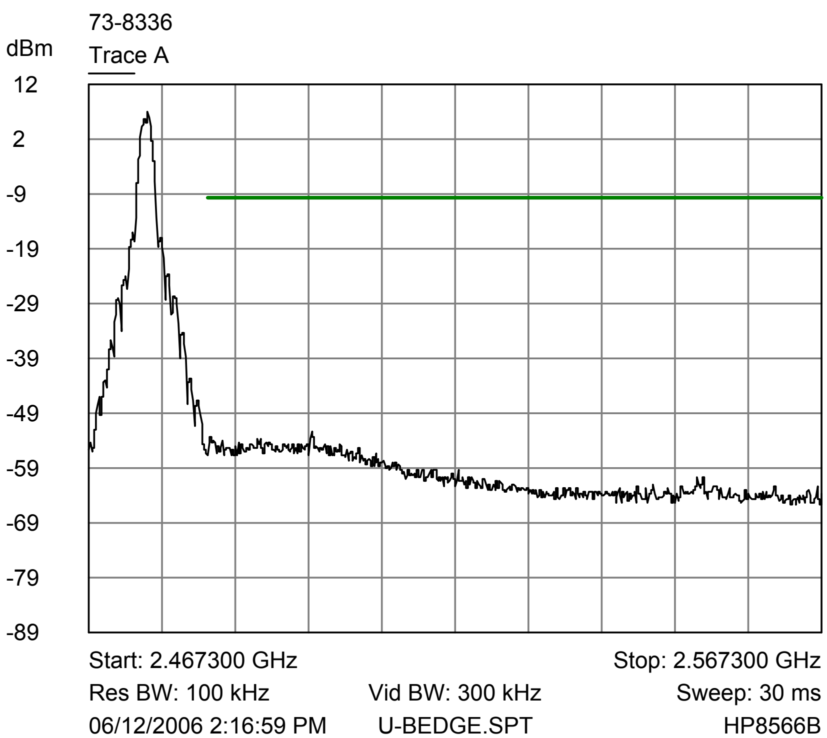
A diagram of the test configuration and the test equipment used is provided in Appendix 1.

RESULT

Spurious emissions must be attenuated below –9.3 dBm. The highest emission noted was at –49.6 dBm; therefore, the EUT complies with the specification.



Trace A Lower channel band edge plot



Trace A Upperchannel band edge plot

Transmitting on the Lowest Channel (2.405 GHz)

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4810.0	-50.9	-9.3
7215.0	-61.1	-9.3
9620.0	-60.5	-9.3
12025.0	-59.9	-9.3
14430.0	-57.5	-9.3
16835.0	-56.5	-9.3
19240.0	-53.8	-9.3
21645.0	-50.4	-9.3
24050.0	-52.0	-9.3

Transmitting on the Middle Channel (2.440 GHz)

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4880.0	-50.7	-9.3
7320.0	-61.6	-9.3
9760.0	-61.4	-9.3
12200.0	-61.5	-9.3
14640.0	-56.9	-9.3
17080.0	-57.6	-9.3
19520.0	-53.7	-9.3
21960.0	-52.4	-9.3
24400.0	-52.0	-9.3

Transmitting on the Highest Channel (2.475 GHz)

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)
4950.0	-49.6	-9.3
7425.0	-60.1	-9.3
9900.0	-60.6	-9.3
12375.0	-62.1	-9.3
14850.0	-57.3	-9.3
17325.0	-57.5	-9.3
19800.0	-54.1	-9.3
22275.0	-52.3	-9.3
24750.0	-52.0	-9.3

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. Shown below are plots with the EUT tuned to the upper and lower channels using both the internal etched PCB antenna and the dipole antenna with the highest gain of 3.2 dBi. 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 7.5 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.

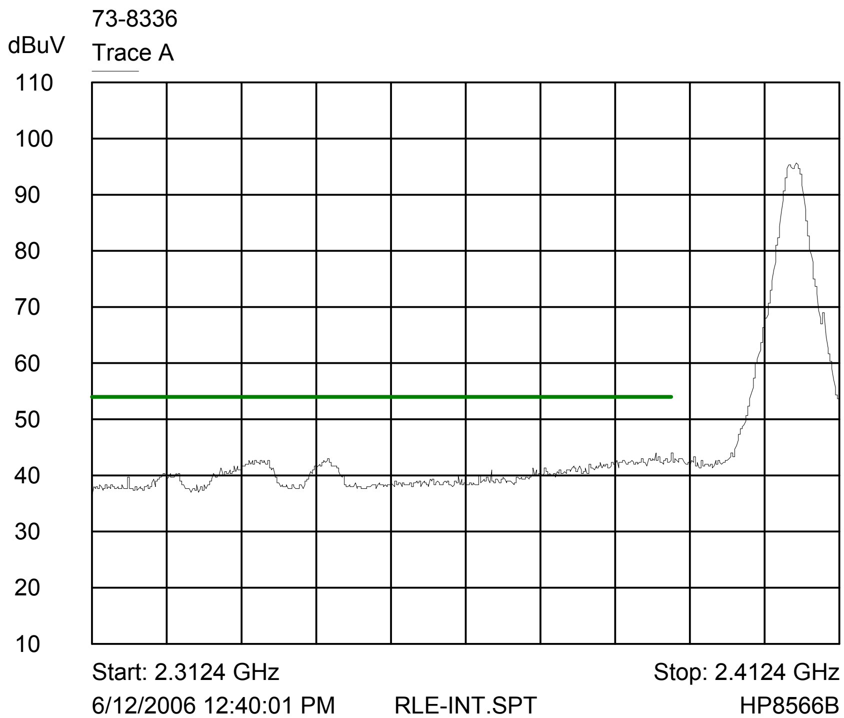
A diagram of the test configuration and the test equipment used is enclosed in Appendix 1. For frequencies below 1000 MHz RBW = 100 kHz and VBW = 300 kHz, For frequencies above 1000 MHz RBW = 1 Mhz and VBW = 3 MHz. For average readings the VBW was reduced to 10 Hz and the sweep set to Auto (5 seconds at 100 Hz span).

AVERAGE FACTOR

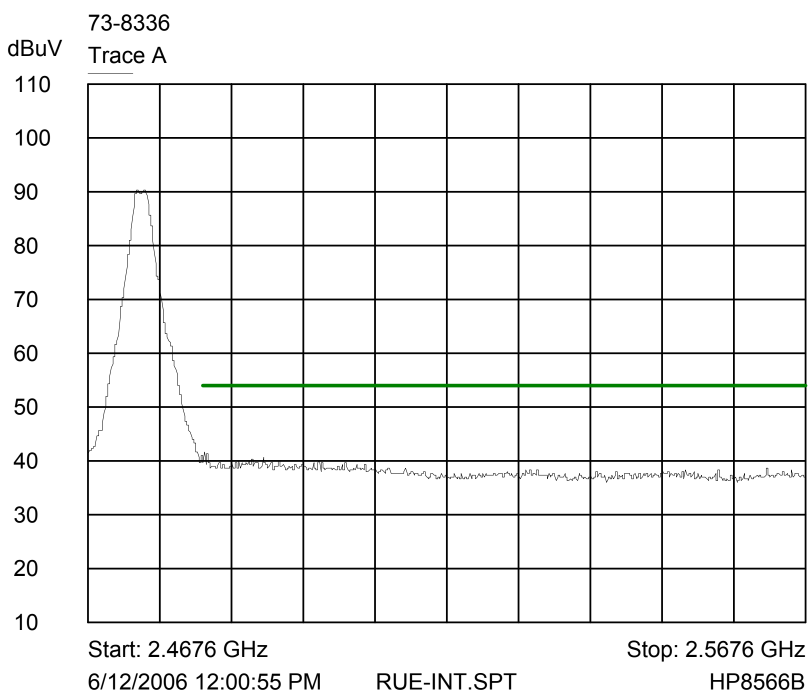
The EUT transmits continuously therefore; there is not an average factor for this device.

RESULT

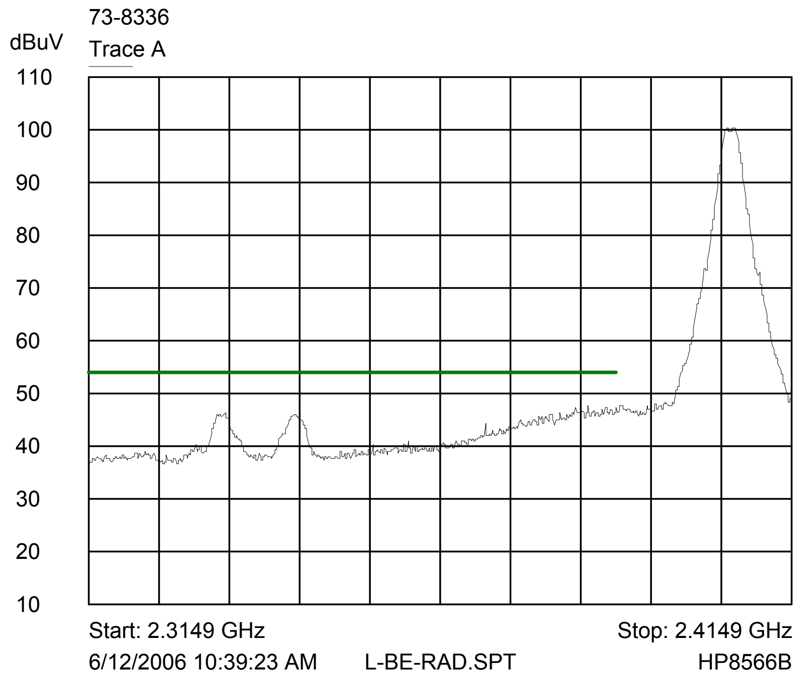
All emissions in the restricted bands of §15.205 met the limits specified in §15.209; therefore, the EUT complies with the specification.



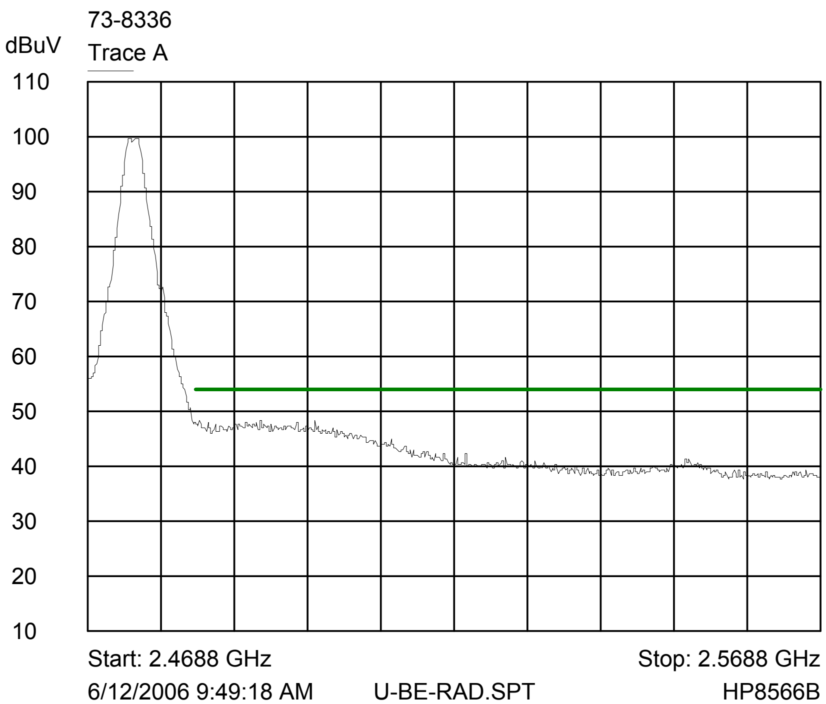
Trace A Lower band edge plot - radiated - internal etched antenna



Trace A Upper band edge plot - radiated - internal antenna



Trace A Lower band edge plot - radiated - external 3.2 dBi antenna



Trace A Upper band edge plot - radiated - external 3.2 dBi antenna

Transmitting at the Lowest Frequency (2.405 GHz)

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2390.0	Peak	Vertical	18.9	29.7	48.6	74.0	-25.4
2390.0	Average	Vertical	7.3	29.7	37.0	54.0	-17.0
2390.0	Peak	Horizontal	11.1	29.7	40.8	74.0	-33.2
2390.0	Average	Horizontal	-0.5	29.7	29.2	54.0	-24.8
4810.0	Peak	Vertical	18.7	35.3	54.0	74.0	-20.0
4810.0	Average	Vertical	12.8	35.3	48.1	54.0	-5.9
4810.0	Peak	Horizontal	8.3	35.3	43.6	74.0	-30.4
4810.0	Average	Horizontal	-2.1	35.3	33.2	54.0	-20.8
7215.0	Peak	Vertical	11.3	39.0	50.3	74.0	-23.7
7215.0	Average	Vertical	0.7	39.0	39.7	54.0	-14.3
7215.0	Peak	Horizontal	9.4	39.0	48.4	74.0	-25.6
7215.0	Average	Horizontal	-2.9	39.0	36.1	54.0	-17.9

No other emissions were seen in the restricted bands.

Transmitting at the Middle Frequency (2.440 GHz)

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4880.0	Peak	Vertical	20.3	35.5	55.8	74.0	-18.2
4880.0	Average	Vertical	13.4	35.5	48.9	54.0	-5.1
4880.0	Peak	Horizontal	9.3	35.5	44.8	74.0	-29.2
4880.0	Average	Horizontal	-0.3	35.5	35.2	54.0	-18.8
7320.0	Peak	Vertical	10.8	39.3	50.1	74.0	-23.9
7320.0	Average	Vertical	-0.7	39.3	38.6	54.0	-15.4
7320.0	Peak	Horizontal	9.0	39.3	48.3	74.0	-25.7
7320.0	Average	Horizontal	-2.9	39.3	36.4	54.0	-17.6

No other emissions were seen in the restricted bands.

Transmitting at the Highest Frequency (2.475 GHz)

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2483.5	Peak	Vertical	23.9	29.9	53.8	74.0	-20.2
2483.5	Average	Vertical	11.0	29.9	40.9	54.0	-13.1
2483.5	Peak	Horizontal	12.1	29.9	42.0	74.0	-32.0
2483.5	Average	Horizontal	2.7	29.9	32.6	54.0	-21.4
4950.0	Peak	Vertical	23.1	35.8	58.9	74.0	-15.1
4950.0	Average	Vertical	14.9	35.8	50.7	54.0	-3.3
4950.0	Peak	Horizontal	13.5	35.8	49.3	74.0	-24.7
4950.0	Average	Horizontal	2.6	35.8	38.4	54.0	-15.6
7425.0	Peak	Vertical	9.4	39.6	49.0	74.0	-25.0
7425.0	Average	Vertical	1.4	39.6	41.0	54.0	-13.0
7425.0	Peak	Horizontal	8.2	39.6	47.8	74.0	-26.2
7425.0	Average	Horizontal	-3.3	39.6	36.3	54.0	-17.7

No other emissions were seen in the restricted bands.

6.2.6 §15.247(d) Peak Power Spectral Density

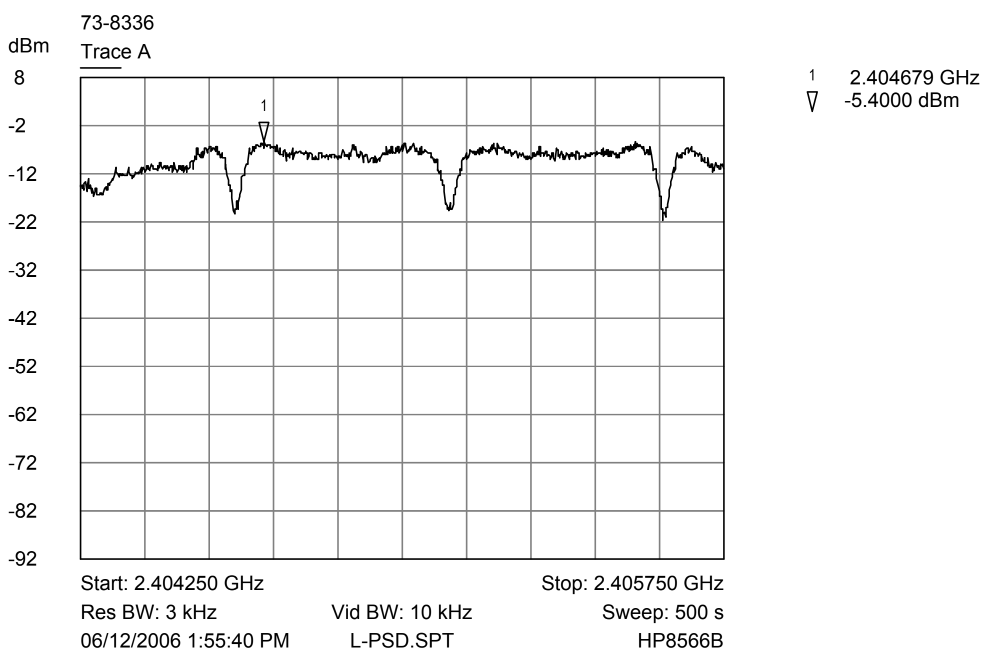
The peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. The plots are shown below and the results of this testing are summarized in the table below.

Frequency (MHz)	Measurement (dBm)	Criteria (dBm)	Margin (dBm)
2404.68	-5.4	8.0	-13.4
2440.54	-4.4	8.0	-12.4
2474.89	-4.0	8.0	-12.0

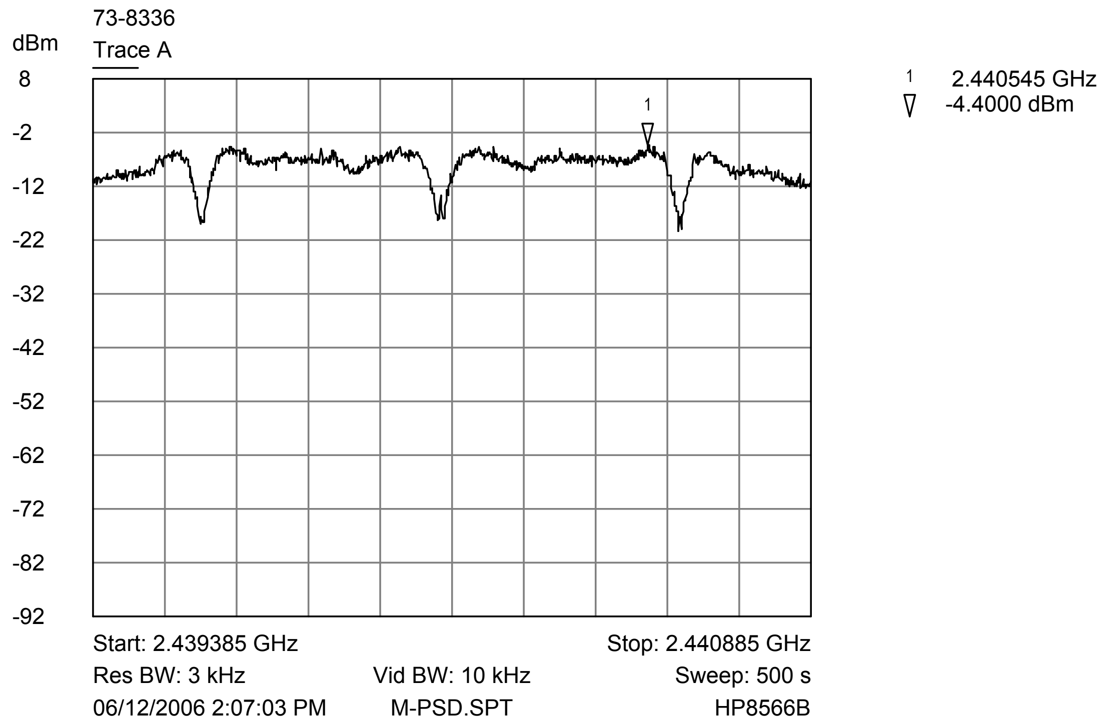
A diagram of the test setup is included in Appendix 1. The spectrum analyzer RBW was set to 3 kHz and the VBW set greater than the RBW. The span was set to 1.5 MHz and the sweep was set to 500 seconds **(**Sweep = (Span/3 kHz)**)**.

RESULT

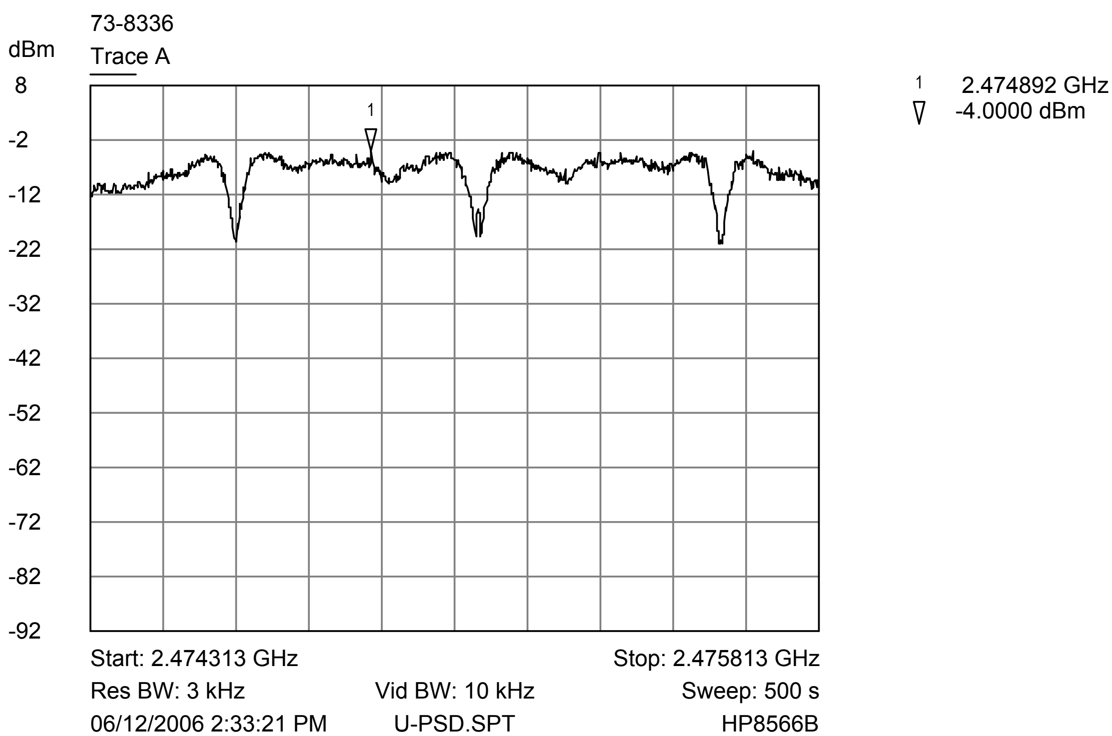
The maximum peak power spectral density was –4.0 dBm. The limit is 8 dBm. The EUT complies with the specification by 12 dB.



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

§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:

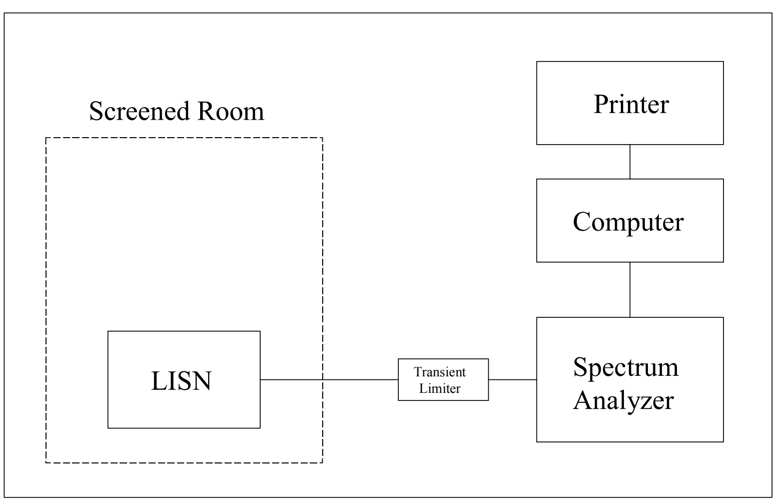
a) Each power cord, which is terminated in a mains supply plug, shall be tested separately.
b) Power cords, which are not specified by the manufacturer to be connected via a host unit, shall be tested separately.
c) Power cords which are specified by the manufacturer to be connected via a host unit or 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	CCL	N/A	N/A	10/28/2005
Test Software	CCL	Conducted Emissions	Revision 1.2	N/A
Spectrum Analyzer	Hewlett Packard	8566B	2230A01711	10/10/2005
Quasi-Peak Detector	Hewlett Packard	85650A	2043A00137	03/06/2006
LISN	EMCO	3825/2	9508-2435	03/15/2006
Conductance Cable Wanship Site #2	CCL	Cable J	N/A	12/12/2005
Transient Limiter	Hewlett Packard	11947A	3107A02266	12/12/2005

An independent calibration laboratory or CCL 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



§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.

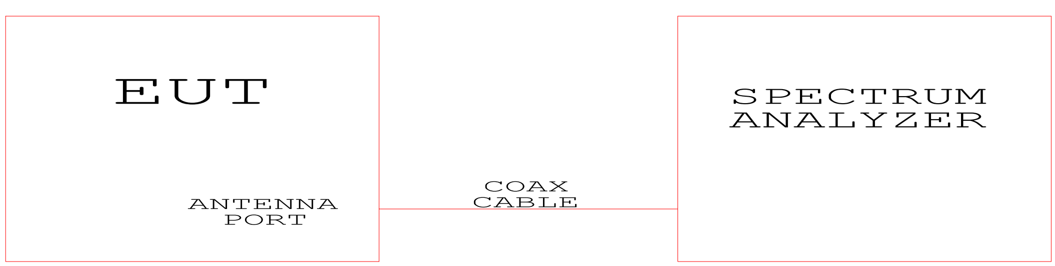
The spectrum analyzer’s resolution bandwidth and video bandwidth were set as follows:

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
Low Loss Cable (1 dB)	N/A	N/A	N/A

An independent calibration laboratory or CCL 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



§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:

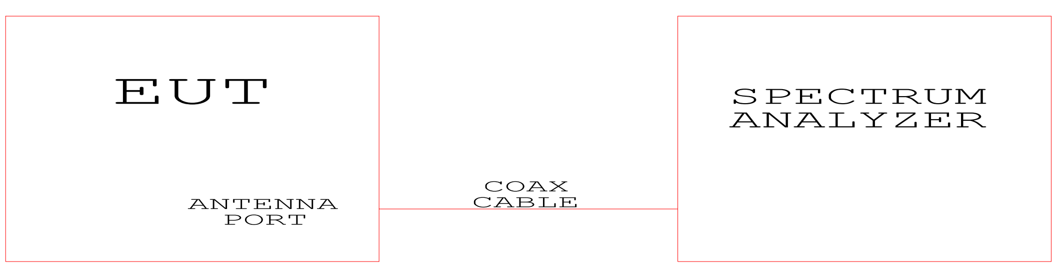
RBW = 3 MHz

VBW = 3 MHz

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

An independent calibration laboratory or CCL 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



§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.

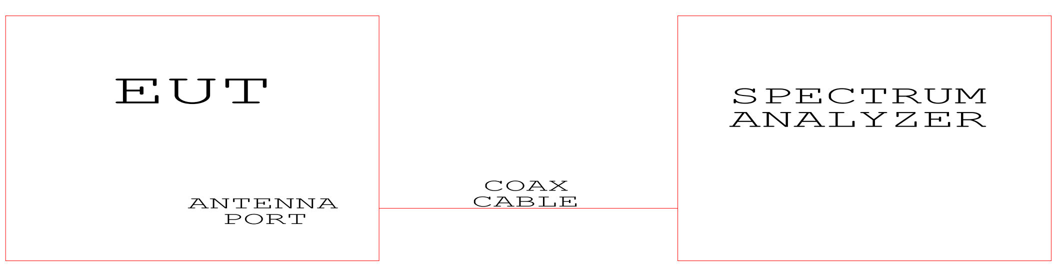
The spectrum analyzer's resolution bandwidth and video bandwidth were set as follows:

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
Low Loss Cable (1 dB)	N/A	N/A	N/A

An independent calibration laboratory or CCL 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



§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 video bandwidth was set to 10 Hz.

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 from the EUT. The readings obtained by these antennas are correlated to the levels obtained with a tuned dipole antenna by adding antenna factors.

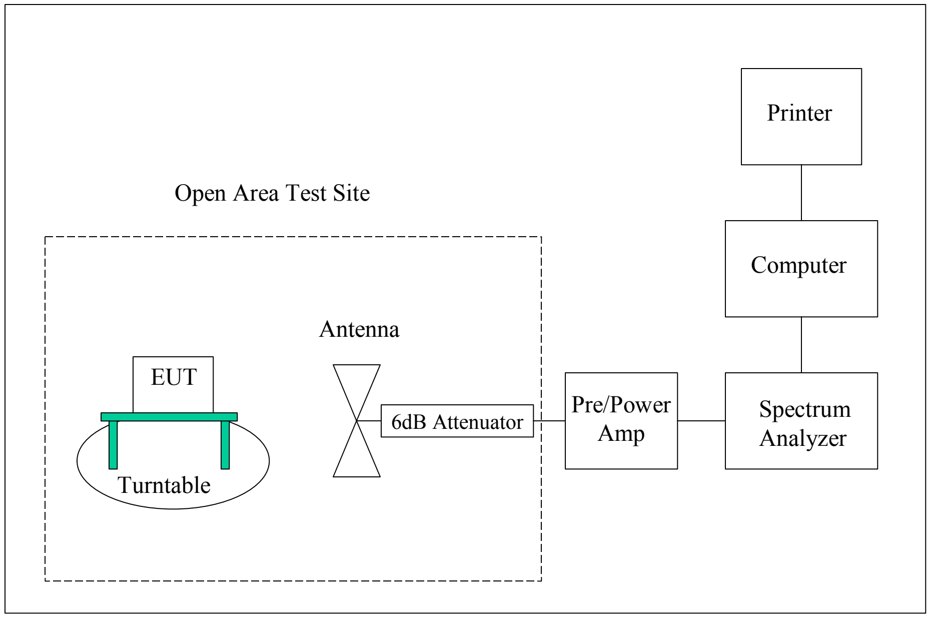
The configuration of the intentional radiator was varied to find the maximum radiated emission. The intentional radiator was connected to the peripherals listed in Section 2.4 via the interconnecting cables listed in Section 2.5. These interconnecting cables were manipulated manually by a technician 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 were 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	CCL	N/A	N/A	10/28/2005
Test Software	CCL	Radiated Emissions	Revision 1.3	N/A
Spectrum Analyzer	Hewlett Packard	8566B	2230A01711	10/10/2005
Quasi-Peak Detector	Hewlett Packard	85650A	2043A00137	03/06/2006
Biconilog Antenna	EMCO	3142	9601-1009	12/28/2005
Double Ridged Guide Antenna	EMCO	3115	9604-4779	05/26/2005
High Frequency Amplifier	Hewlett Packard	8449B	3008A00990	05/25/2005
Pyramidal Horn Antenna	EMCO	3160-09	0003-1197	04/18/2006
Harmonic Mixer	Hewlett Packard	11970K	3003A05756	04/18/2006
3 Meter Radiated Emissions Cable Wanship Site #2	CCL	Cable K	N/A	12/12/2005
Pre/Power-Amplifier	Hewlett Packard	8447F	3113A05161	09/19/2005
6 dB Attenuator	Hewlett Packard	8491A	32835	12/12/2005

An independent calibration laboratory or CCL 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



§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.

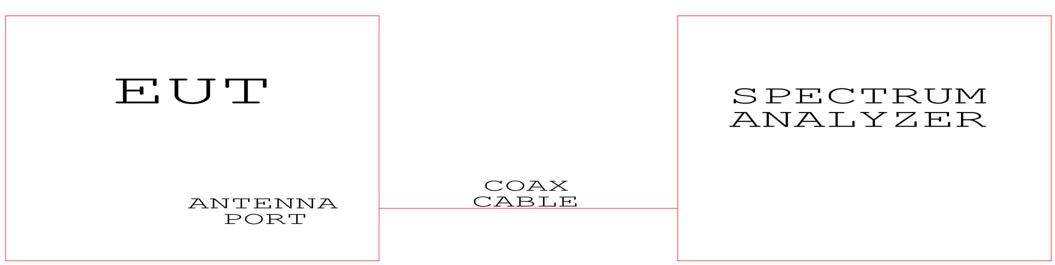
The spectrum analyzer's resolution bandwidth and video bandwidth were set as follows:

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
Low Loss Cable (1 dB)	N/A	N/A	N/A

An independent calibration laboratory or CCL 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 Spurious Emission Worst Case Configuration

Photograph 2 – Back View Radiated Spurious Emission Worst Case Configuration

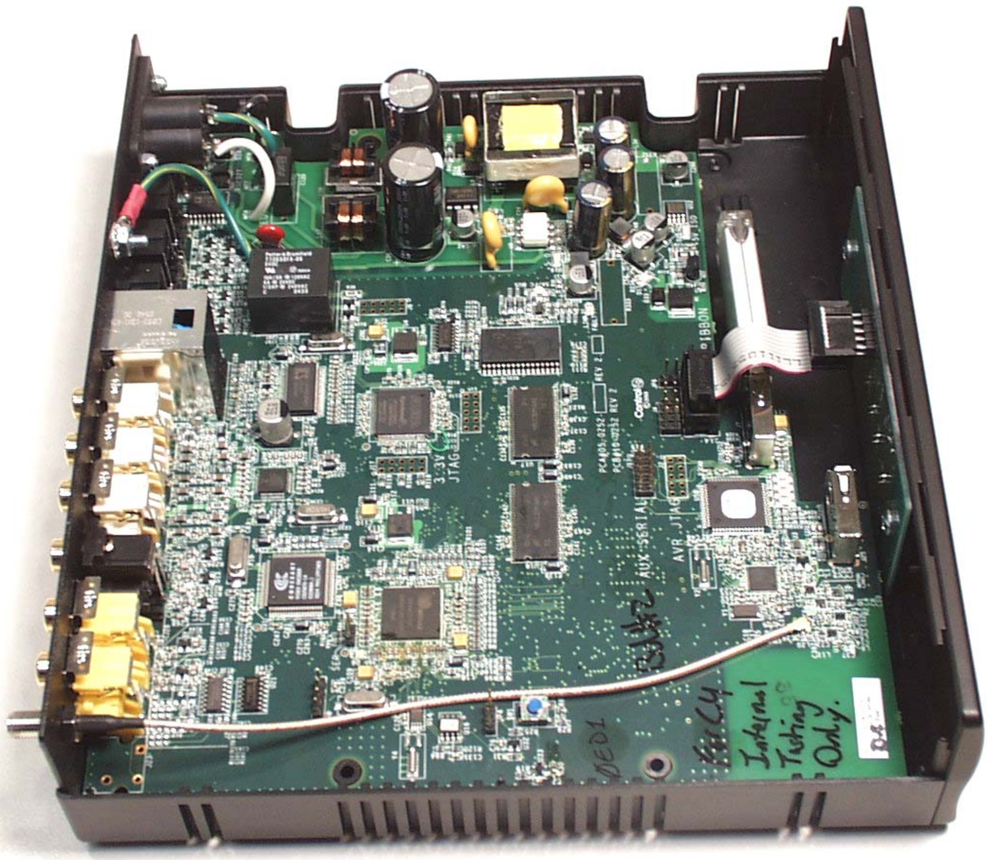
Photograph 3 – Front View Conducted Disturbance Worst Case Configuration

Photograph 4 – Back View Conducted Disturbance Worst Case Configuration

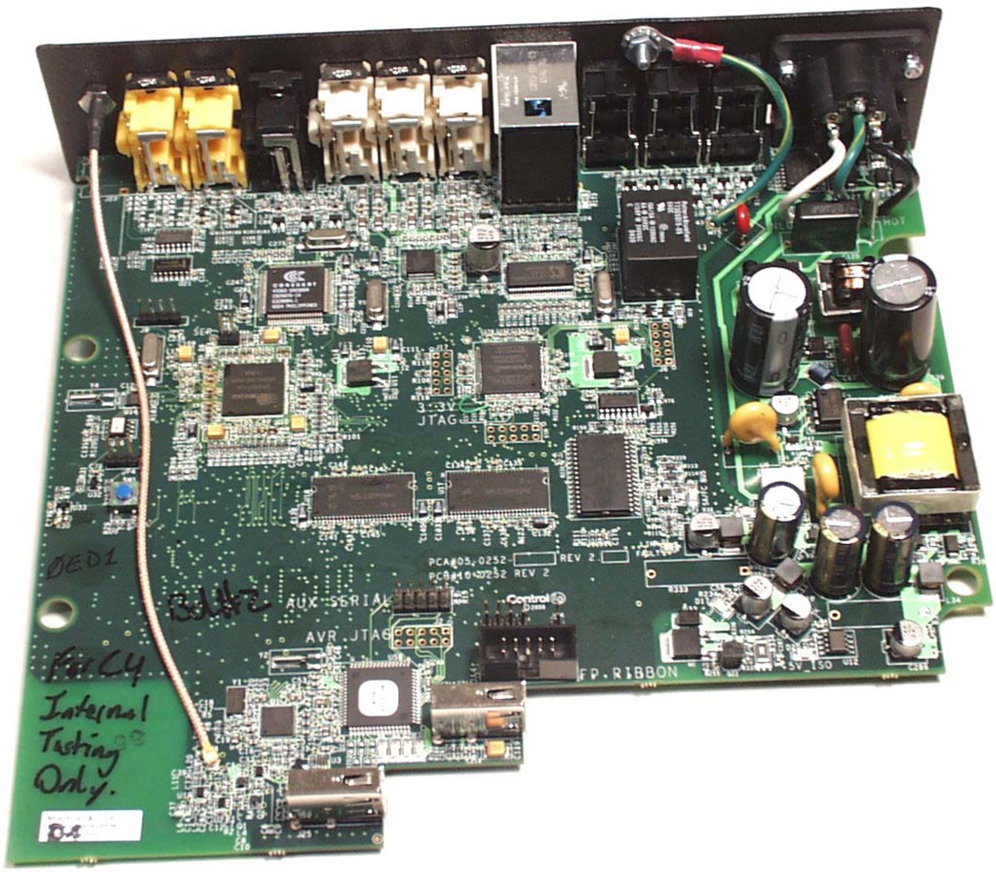
Photograph 5 – Front View of the EUT

Photograph 6 – Back View of the EUT

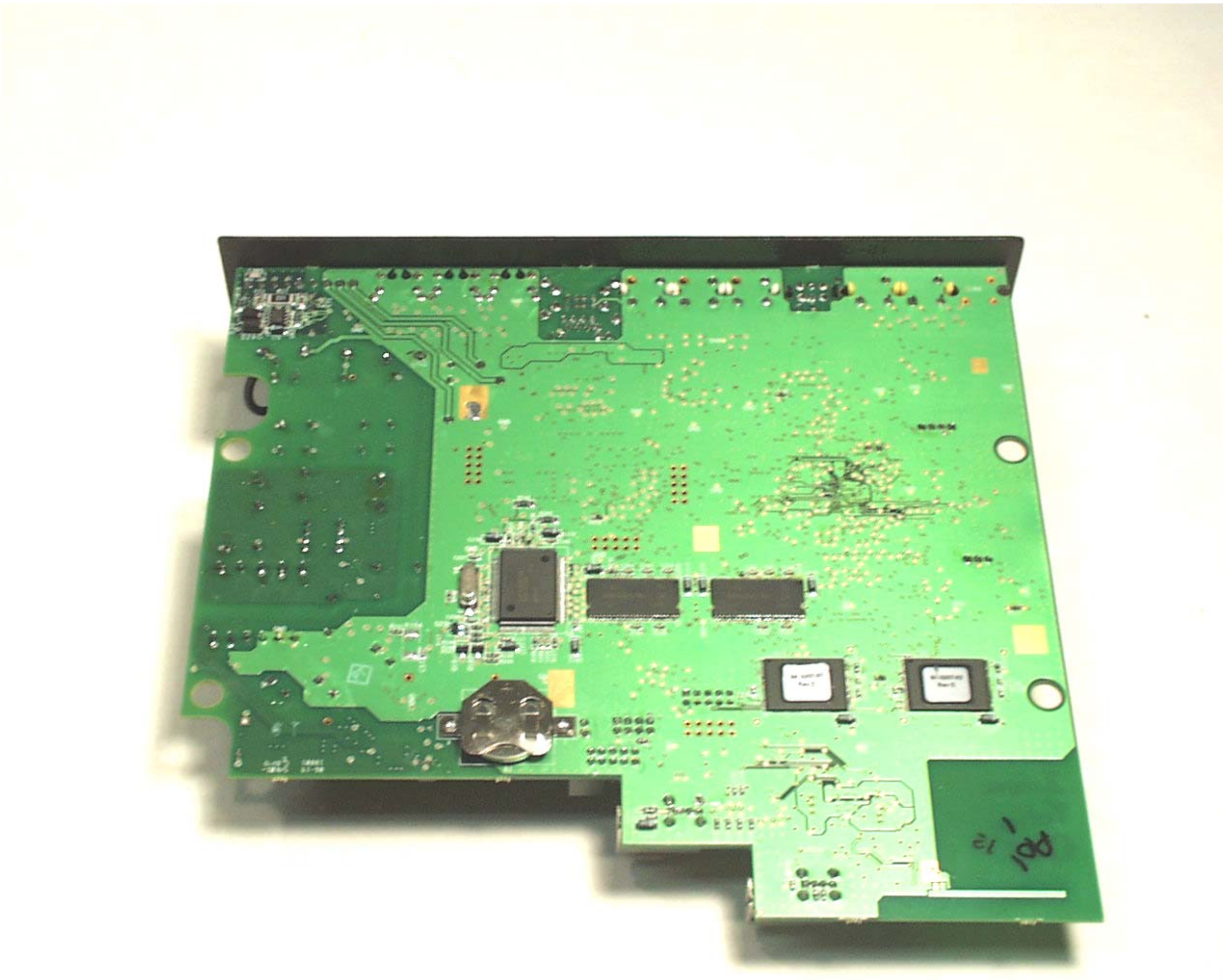
Photograph 7 – Internal View of the EUT



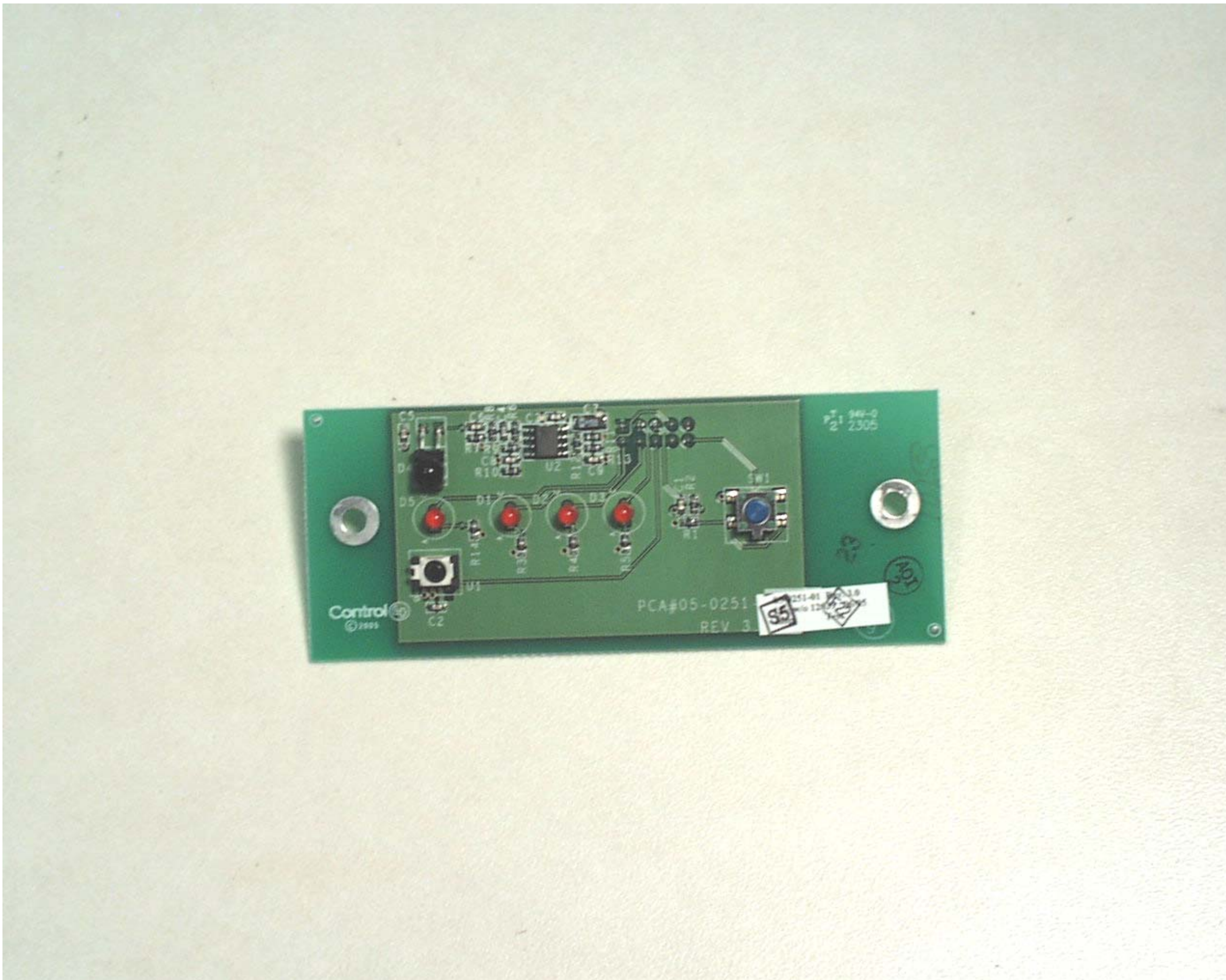
Photograph 8 – View of the Component Side of the Main PCB



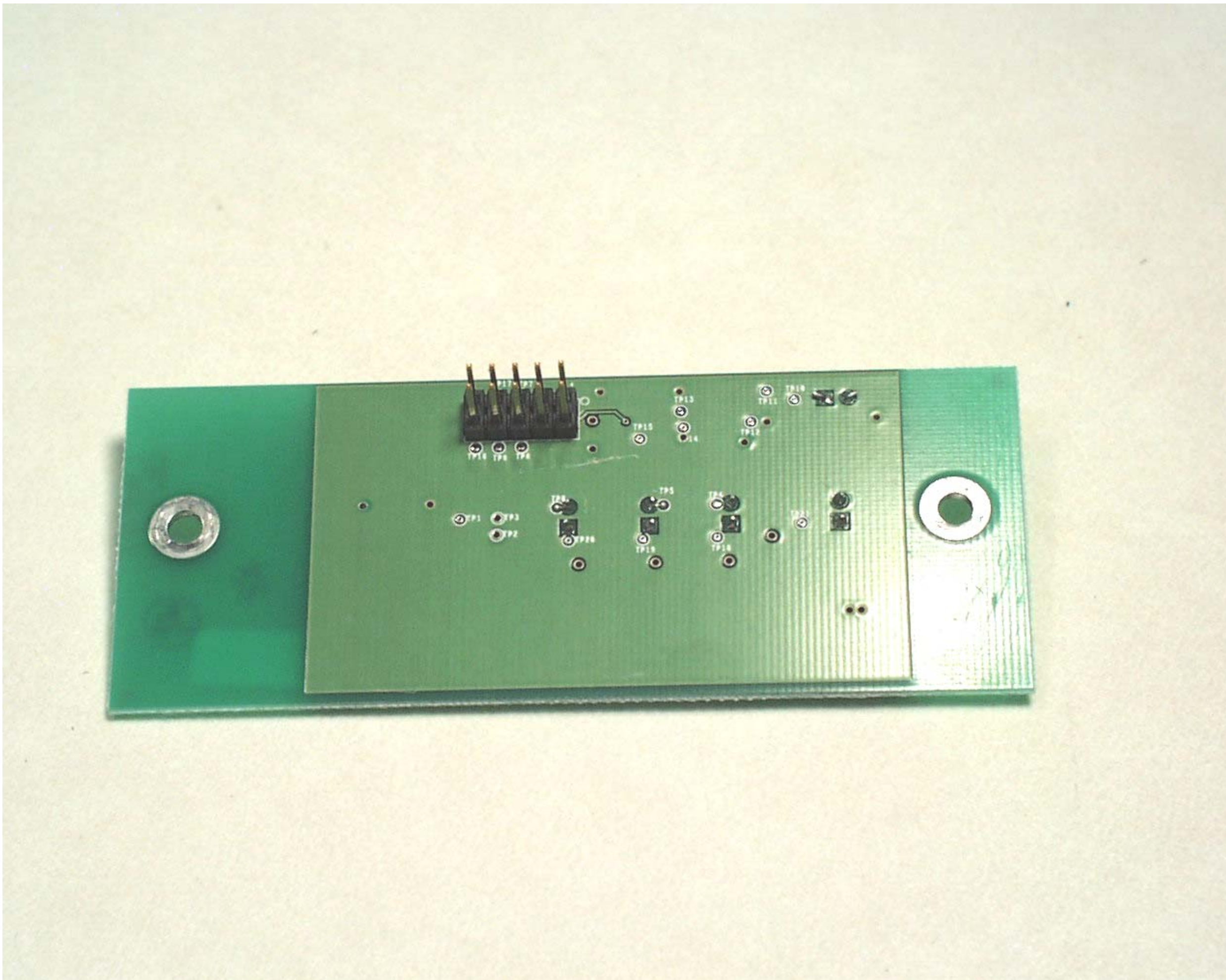
Photograph 9 – View of the Trace Side of the Main PCB



Photograph 10 – View of the Component Side of the Front Panel PCB



Photograph 11 - View of the Trace Side of the Front Panel PCB



Photograph 12 – Photograph of the Optional External Dipole Antennas