Excellence in Compliance Testing

Certification Test Report

FCC ID: YWZ-HBHT
IC: 3356F-HBHT

FCC Rule Part: 15.247
IC Radio Standards Specification: RSS-210

ACS Report Number: 11-0376.W06.11.A

Manufacturer: Alpha - High Theft Solutions
Model: HB Hard Tag

Test Begin Date: October 11, 2011
Test End Date: October 11, 2011
Report Issue Date: October 17, 2011

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 200612-0

This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

Reviewed by:

Kirby Munroe
Director, Wireless Certifications
ACS, Inc.

This report contains 19 pages

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1 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 15 Subpart C of the FCC's Code of Federal Regulations and Industry Canada's Radio Standards Specification RSS-210.

1.2 General

The HB Hard Tag provides article surveillance for retail environments. It attaches to the product by means of a pin with a large head penetrating the soft material of a product or through an existing hole in the product. The pin is locked to the device by the use of a 3 ball cone clutch mechanism.

The HB Hard Tag includes a replaceable CR2477 battery and an 802.15.4 Based 2.4 GHz radio transceiver.

Technical Information:
Band of Operation: 2405 – 2480 MHz
Number of Channels: 16
Modulation Format: O-QPSK
Antenna Type/Gain: Printed circuit board wiggle antenna; 2.15dBi (0dBd)
Operating Voltage: 3V CR2477 Lithium Battery

Manufacturer Information:
Alpha - High Theft Solutions
10715 Sikes Place, Ste. 200
Charlotte, NC 28277

Test Sample Serial Number: 00-00-00-57

Test Sample Condition: The test samples were provided in good working order with no visible defects.

1.3 Test Methodology and Considerations

For radiated emissions, including band edge, three orientations of the EUT were evaluated.

For the purpose of RF conducted measurements, the EUT was modified with a temporary 50 ohm antenna port.

2 TEST FACILITIES

2.1 Location

The radiated and conducted emissions test sites are located at the following address:

Advanced Compliance Solutions
5015 B.U. Bowman Drive
Buford, GA 30518
Phone: (770) 831-8048
Fax: (770) 831-8598

2.2 Laboratory Accreditations/Recognitions/Certifications

ACS is accredited to ISO/IEC 17025 by the National Institute of Standards and Technology under their National Voluntary Laboratory Accreditation Program (NVLAP), Lab Code 200612-0. Unless otherwise specified, all tests methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

The Semi-Anechoic Chamber Test Site, Open Area Test Site (OATS) and Conducted Emissions Site have been fully described, submitted to, and accepted by the FCC, Industry Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

FCC Registration Number: 511277
Industry Canada Lab Code: IC 4175A-1
VCCI Member Number: 1831

- VCCI OATS Registration Number R-1526
- VCCI Conducted Emissions Site Registration Number: C-1608

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of a 20' x 30' x 18' shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 101 x 101 x 19mm thick and weighs approximately 550 grams. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber.

The turntable is 150cm in diameter and is located 160cm from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is all steel, flush mounted table installed in an all steel frame. The table is remotely operated from inside the control room located 25' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Behind the turntable is a 3' x 6' x 4' deep shielded pit used for support equipment if necessary. The pit is equipped with 1 - 4" PVC chases from the turntable to the pit that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit.

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3-1 below:

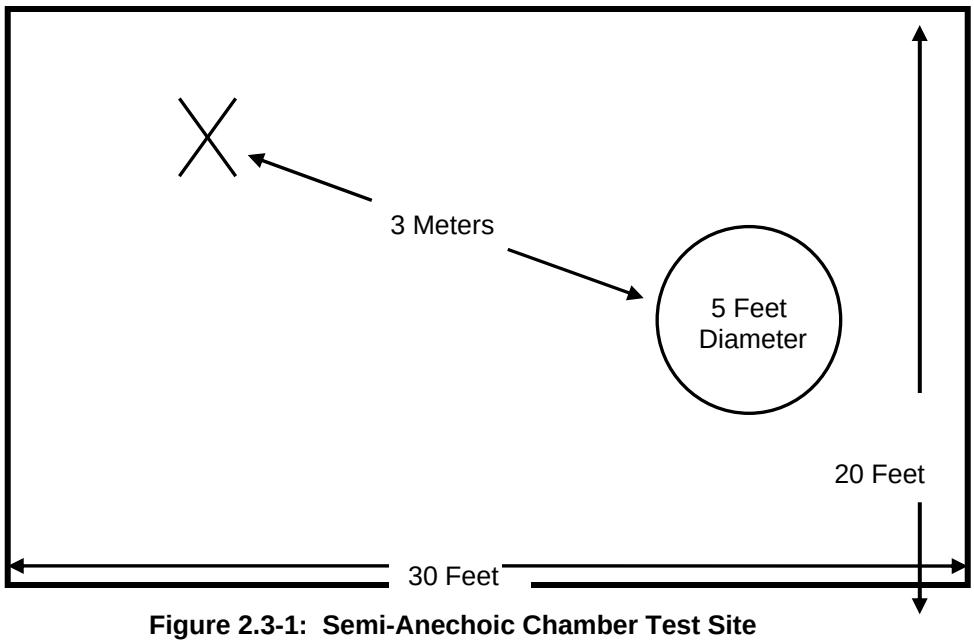


Figure 2.3-1: Semi-Anechoic Chamber Test Site

2.3.2 Open Area Tests Site (OATS)

The open area test site consists of a 40' x 66' concrete pad covered with a perforated electro-plated galvanized sheet metal. The perforations in the sheet metal are 1/8" holes that are staggered every 3/16". The individual sheets are placed to overlap each other by 1/4" and are riveted together to provide a continuous seam. Rivets are spaced every 3" in a 3 x 20 meter perimeter around the antenna mast and EUT area. Rivets in the remaining area are spaced as necessary to properly secure the ground plane and maintain the electrical continuity.

The entire ground plane extends 12' beyond the turntable edge and 16' beyond the antenna mast when set to a 10 meter measurement distance. The ground plane is grounded via 4 - 8' copper ground rods, each installed at a corner of the ground plane and bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is an all aluminum 10' flush mounted table installed in an all aluminum frame. The table is remotely operated from inside the control room located 40' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Adjacent to the turntable is a 7' x 7' square and 4' deep concrete pit used for support equipment if necessary. The pit is equipped with 5 - 4" PVC chases from the pit to the control room that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit. The pit is covered with 2 sheets of 1/4" diamond style re-enforced steel sheets. The sheets are painted to match the perforated steel ground plane; however the underside edges have been masked off to maintain the electrical continuity of the ground plane. All reflecting objects are located outside of the ellipse defined in ANSI C63.4.

A diagram of the Open Area Test Site is shown in Figure 2.3-2 below:

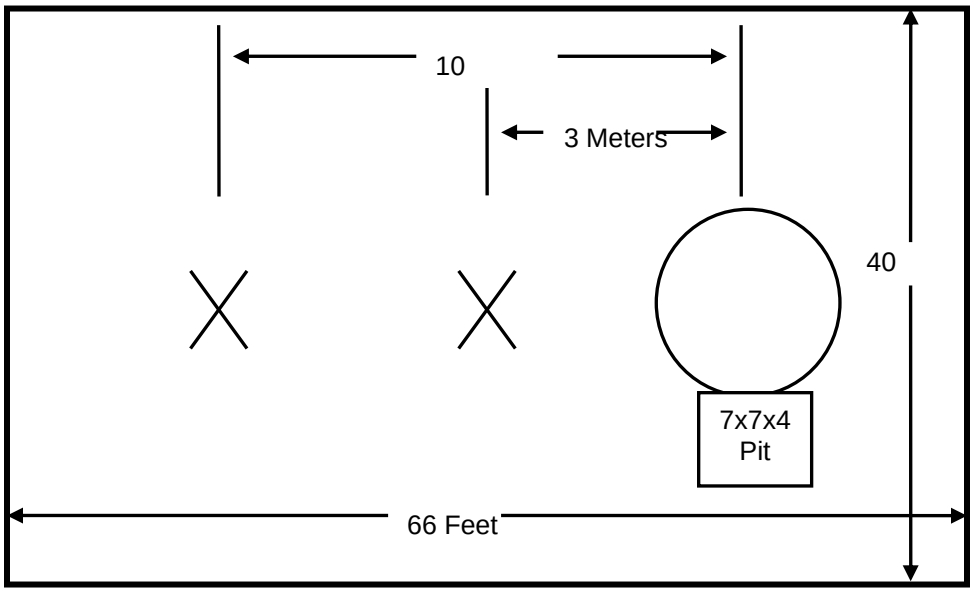


Figure 2.3-2: Open Area Test Site

2.4 Conducted Emissions Test Site Description

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8' x 8' solid aluminum horizontal group reference plane (GRP) bonded every 3" to an 8' X 8' vertical ground plane.

The site is of sufficient size to test table top and floor standing equipment in accordance with section 6.1.4 of ANSI C63.4.

A diagram of the room is shown below in figure 4.1.3-1:

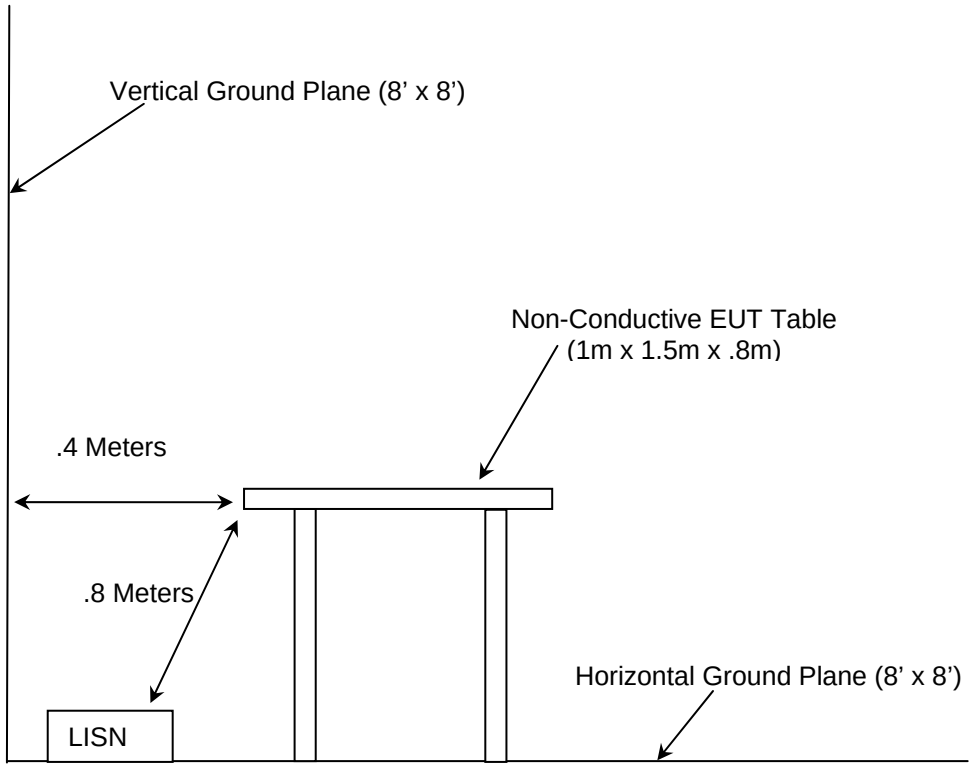


Figure 2.4-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.4-2003: Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the 9KHz to 40GHz
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2011
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2011
- FCC KDB Publication No. 558074 - Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247), March 2005
- Industry Canada Radio Standards Specification: RSS-210 - Low-power License-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment, Issue 8, Dec 2010
- Industry Canada Radio Standards Specification: RSS-GEN – General Requirements and Information for the Certification of Radiocommunication Equipment, Issue 3, Dec 2010.

4 LIST OF TEST EQUIPMENT

The calibration interval of test equipment is annually or the manufacturer's recommendations. Where the calibration interval deviates from the annual cycle based on the instrument manufacturer's recommendations, it shall be stated below.

Table 4-1: Test Equipment

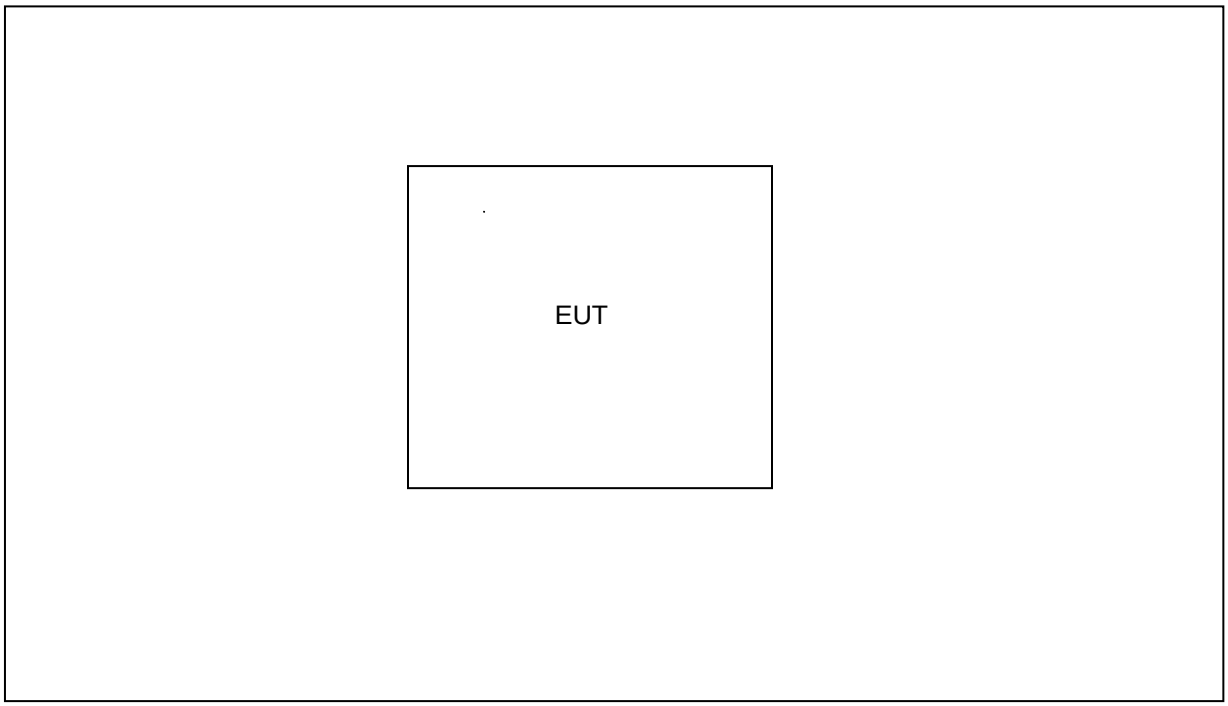
AssetID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
1	Rohde & Schwarz	ESMI - Display	Spectrum Analyzers	833771/007	9/23/2010	9/23/2012
2	Rohde & Schwarz	ESMI-Receiver	Spectrum Analyzers	839587/003	9/23/2010	9/23/2012
30	Spectrum Technologies	DRH-0118	Antennas	970102	4/27/2011	4/27/2013
40	EMCO	3104	Antennas	3211	2/11/2011	2/11/2013
73	Agilent	8447D	Amplifiers	2727A05624	9/30/2011	9/30/2012
283	Rohde & Schwarz	FSP40	Spectrum Analyzers	1000033	8/26/2011	8/26/2012
291	Florida RF Cables	SMRE-200W-12.0-SMRE	Cables	None	12/7/2010	12/7/2011
292	Florida RF Cables	SMR-290AW-480.0-SMR	Cables	None	4/11/2011	4/11/2012
334	Rohde&Schwarz	3160-10	Antennas	45576	11/4/2010	NCR
335	Suhner	SF-102A	Cables	882/2A	8/29/2011	8/29/2012
338	Hewlett Packard	8449B	Amplifiers	3008A01111	3/24/2011	3/24/2012
340	Aeroflex/Weinschel	AS-20	Attenuators	7136	8/29/2011	8/29/2012
345	Suhner Sucoflex	102A	Cables	1077/2A	8/29/2011	8/29/2012
412	Electro Metrics	LPA-25	Antennas	1241	7/28/2010	7/28/2012
422	Florida RF	SMS-200AW-72.0-SMR	Cables	805	12/29/2010	12/29/2011
432	Microwave Circuits	H3G020G4	Filters	264066	7/11/2011	7/11/2012

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number
The EUT operates stand alone therefore no support equipment was utilized.				

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM



7 SUMMARY OF TESTS

Along with the tabular data shown below, plots were taken of all signals deemed important enough to document.

7.1 Antenna Requirement – FCC: Section 15.203

The HB Hard Tag utilizes an integral PCB wiggle antenna which cannot be removed without permanently damaging the device thus satisfying Part 15.203. The gain on the antenna is 2.15dBi (0dBd).

7.2 Power Line Conducted Emissions – FCC: Section 15.207 IC: RSS-Gen 7.2.4

7.2.1 Measurement Procedure

The EUT is battery operated therefore the measurement of AC power line conducted emissions is not applicable.

7.3 6dB / 99% Bandwidth – FCC: Section 15.247(a)(2) IC: RSS-210 A8.2(a)

7.3.1 Measurement Procedure

The 6dB bandwidth was measured in accordance with the FCC KDB Publication No. 558074 "Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)". The RBW of the spectrum analyzer was set to 100 kHz and VBW 300 kHz. Span was set large enough to capture the entire emissions and >> RBW.

The occupied bandwidth measurement function of the analyzer was used for the 99% bandwidth.

7.3.2 Measurement Results

Results are shown below in table 7.3.2-1 and figure 7.3.2-1 to 7.3.2-6:

Table 7.3.2-1: 6dB / 99% Bandwidth

Frequency [MHz]	6dB Bandwidth [MHz]	99% Bandwidth [MHz]
2405	1.57	2.29
2440	1.57	2.33
2480	1.57	2.37

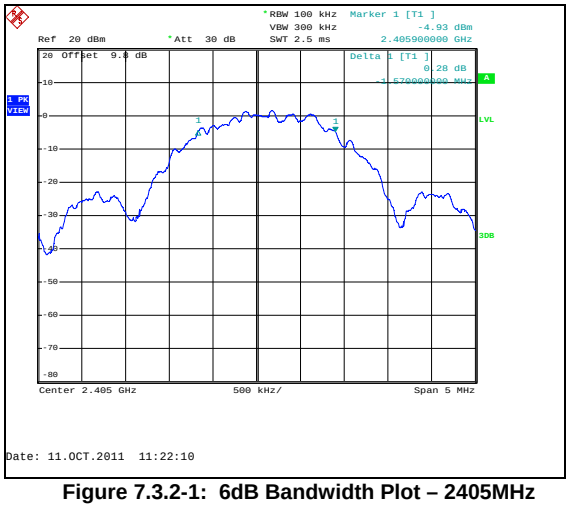


Figure 7.3.2-1: 6dB Bandwidth Plot – 2405MHz

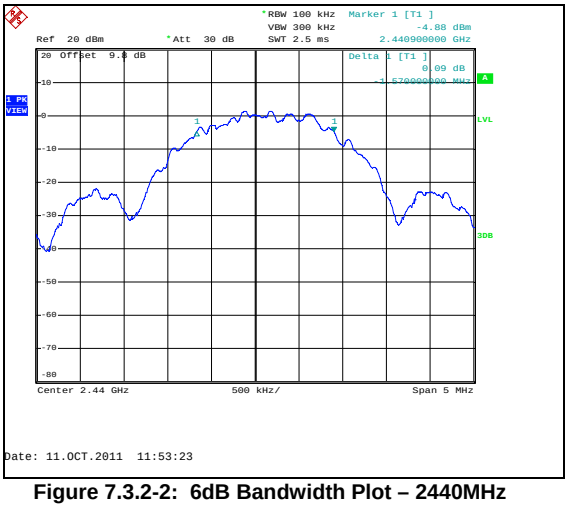


Figure 7.3.2-2: 6dB Bandwidth Plot – 2440MHz

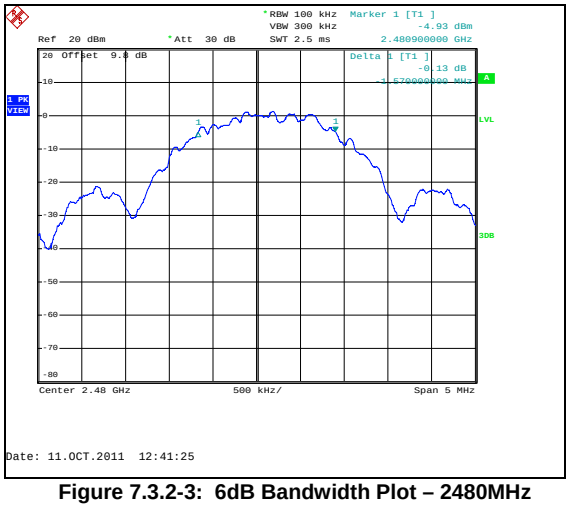


Figure 7.3.2-3: 6dB Bandwidth Plot – 2480MHz

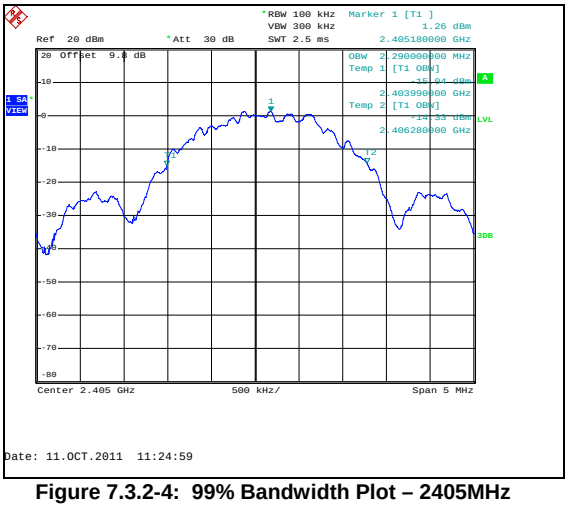


Figure 7.3.2-4: 99% Bandwidth Plot – 2405MHz

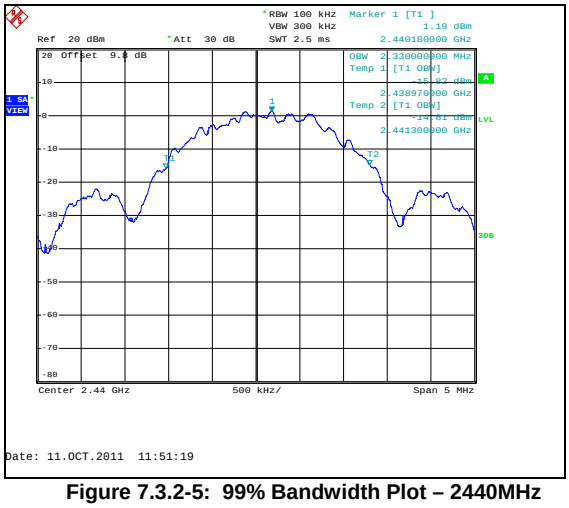


Figure 7.3.2-5: 99% Bandwidth Plot – 2440MHz

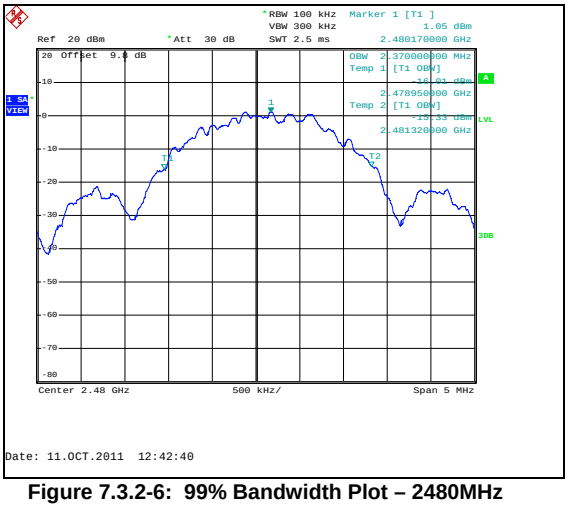


Figure 7.3.2-6: 99% Bandwidth Plot – 2480MHz

7.4 Peak Output Power Requirement - FCC Section 15.247(b)(3) IC: RSS-210 A8.4(4)

7.4.1 Measurement Procedure

The Peak Output Power was measured in accordance with the FCC KDB Publication No. 558074 "Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)" Power Option 1. The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer. Data was collected with the EUT operating at maximum power per channelization.

7.4.2 Measurement Results

Results are shown below in Table 7.4.2-1 and Figures 7.4.2-1 to 7.4.2-3.

Table 7.4.2-1: Peak Output Power

Frequency (MHz)	Output Power (dBm)
2405	3.80
2440	3.94
2480	3.55

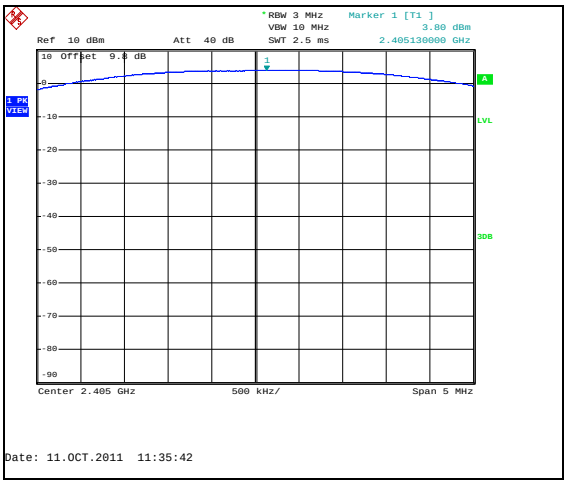


Figure 7.4.2-1: Output power – 2405MHz

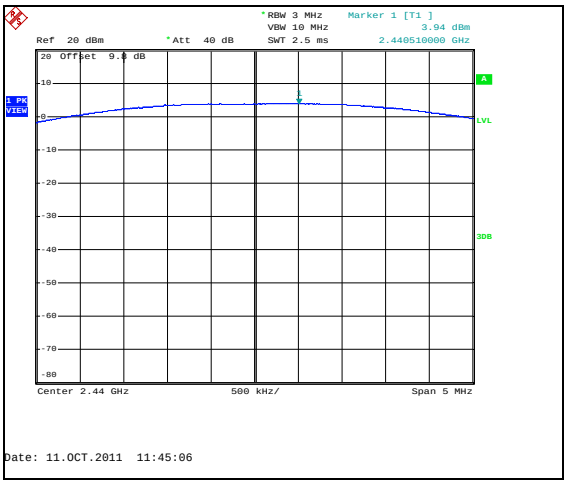


Figure 7.4.2-2: Output power – 2440MHz

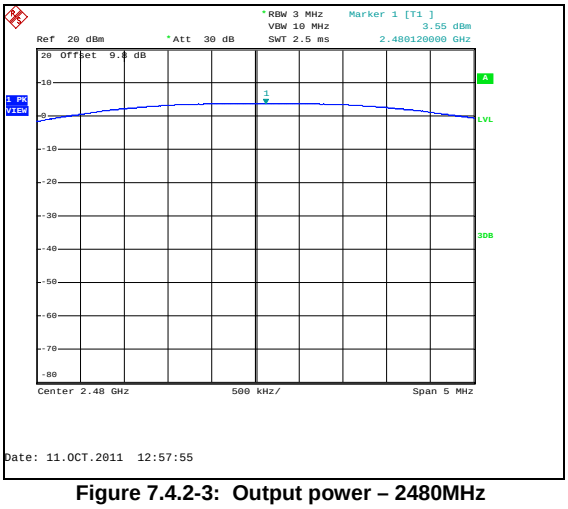


Figure 7.4.2-3: Output power – 2480MHz

7.5 Band-Edge Compliance and Spurious Emissions-FCC 15.247(d) IC:RSS-210 2.2, A8.5

7.5.1 Band-Edge Compliance

7.5.1.1 Measurement Procedure

The EUT was investigated at the low and high channels of operation to determine band-edge compliance. Because the upper band-edge coincides with a restricted band, band-edge compliance for the upper band-edge was determined based on the measurement of the absolute field strength of the highest emission outside the band-edge.

The lower band-edge compliance was determined using the conducted marker-delta method in which the radio frequency power that is produced by the EUT is at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power.

7.5.1.2 Measurement Results

Band-edge compliance is displayed in Tables 7.5.1.2-1 to 7.5.1.2-3 and Figure 7.5.1.2-1.

Table 7.5.1.2-1: Upper Band-edge Radiated Emissions – X Orientation

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
2483.5	63.06	54.30	H	-5.04	58.02	33.01	74.0	54.0	16.00	21.00
2483.5	68.01	59.41	V	-5.04	62.97	38.12	74.0	54.0	11.00	15.90

Table 7.5.1.2-2: Upper Band-edge Radiated Emissions – Y Orientation

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
2483.5	57.83	48.64	H	-5.04	52.79	27.35	74.0	54.0	21.20	26.70
2483.5	69.84	61.16	V	-5.04	64.80	39.87	74.0	54.0	9.20	14.10

Table 7.5.1.2-3: Upper Band-edge Radiated Emissions – Z Orientation

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
2483.5	65.32	56.84	H	-5.04	60.28	35.55	74.0	54.0	13.70	18.50
2483.5	65.72	57.09	V	-5.04	60.68	35.80	74.0	54.0	13.30	18.20

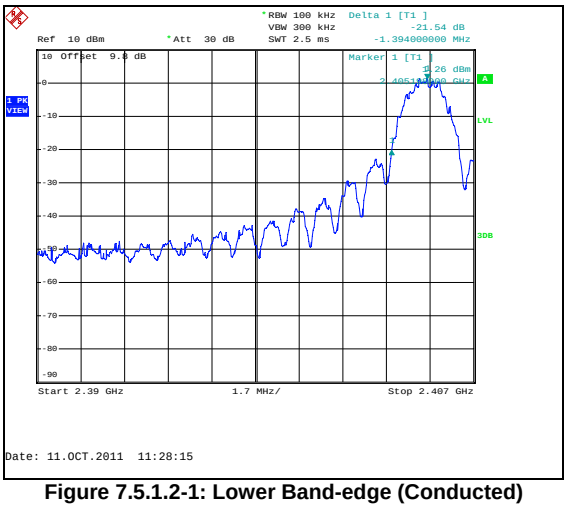


Figure 7.5.1.2-1: Lower Band-edge (Conducted)

7.5.2 RF Conducted Spurious Emissions

7.5.2.1 Measurement Procedure

The RF Conducted Spurious Emissions were measured in accordance with the FCC KDB Publication No. 558074 “Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)”. The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer. The EUT was investigated for conducted spurious emissions from 30MHz to 25GHz, 10 times the highest fundamental frequency. For each measurement, the spectrum analyzer’s RBW was set to 100 kHz and the VBW was set to 300 kHz. The peak detector and Max Hold function of the analyzer were utilized.

7.5.2.2 Measurement Results

RF Conducted Emissions are displayed in Figures 7.5.2.2-1 through 7.5.2.2-9.

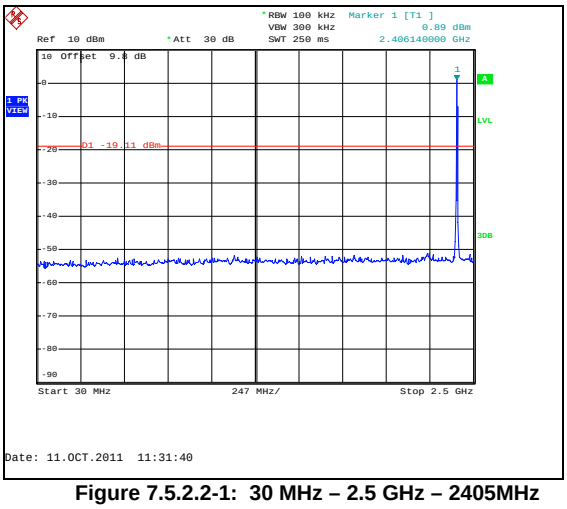


Figure 7.5.2.2-1: 30 MHz – 2.5 GHz – 2405MHz

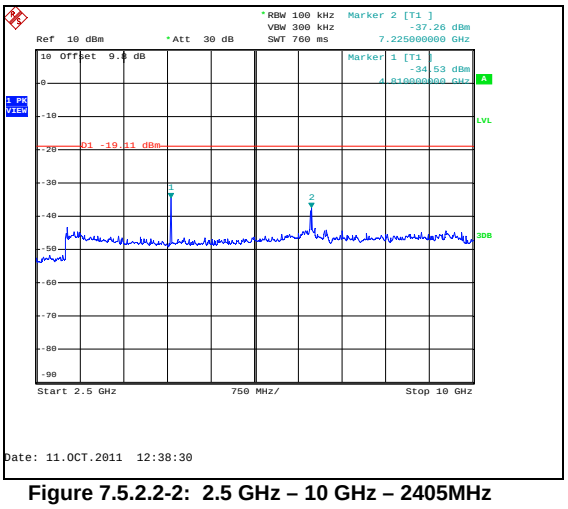


Figure 7.5.2.2-2: 2.5 GHz – 10 GHz – 2405MHz

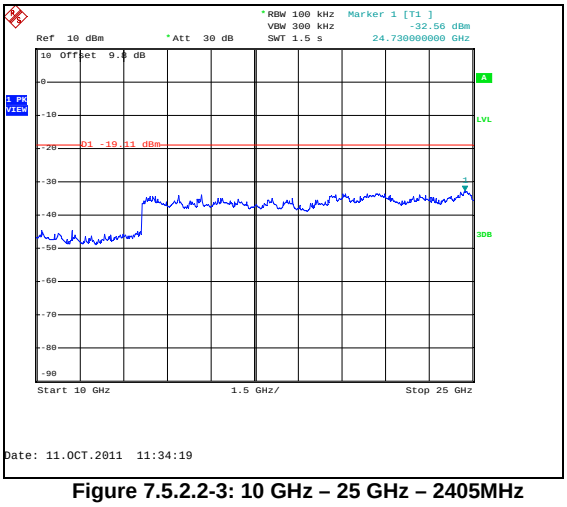


Figure 7.5.2.2-3: 10 GHz – 25 GHz – 2405MHz

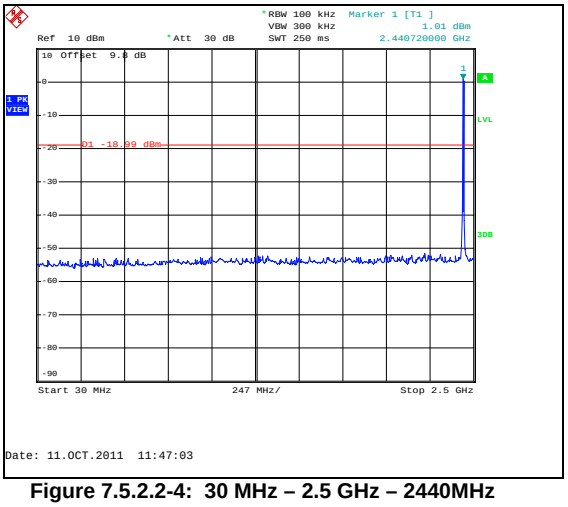


Figure 7.5.2.2-4: 30 MHz – 2.5 GHz – 2440MHz

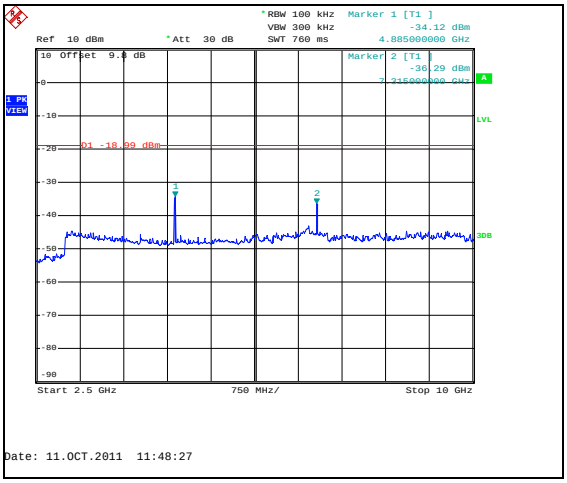


Figure 7.5.2.2-5: 2.5 GHz – 10 GHz – 2440MHz

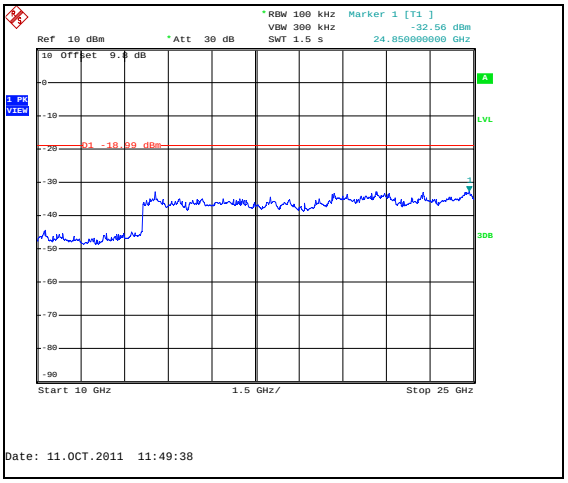


Figure 7.5.2.2-6: 10 GHz – 25 GHz – 2440MHz

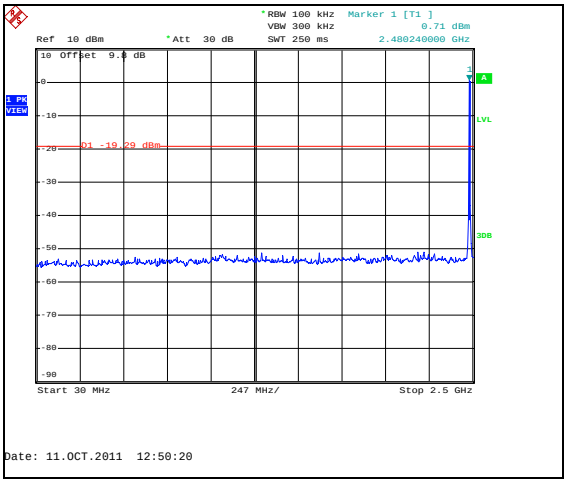


Figure 7.5.2.2-7: 30 MHz – 2.5 GHz – 2480MHz

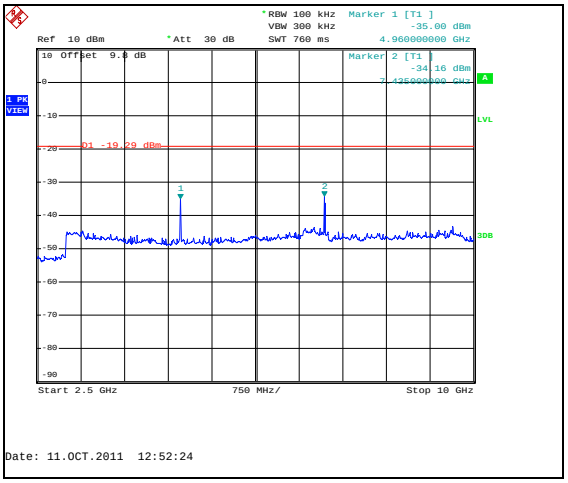


Figure 7.5.2.2-8: 2.5 GHz – 10 GHz – 2480MHz

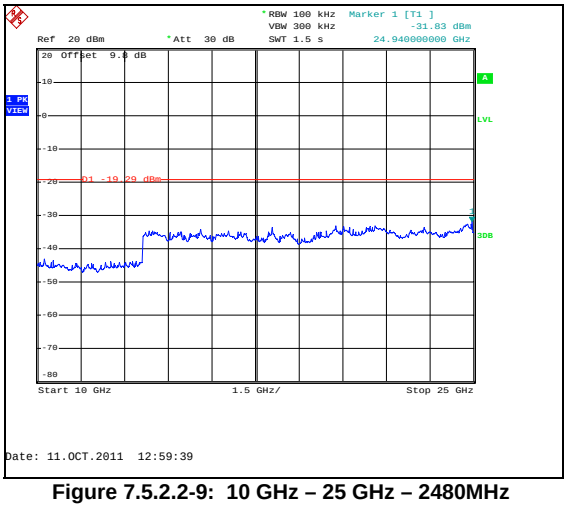


Figure 7.5.2.2-9: 10 GHz – 25 GHz – 2480MHz

7.5.3 Radiated Spurious Emissions (Restricted Bands)

7.5.3.1 Measurement Procedure

Radiated emissions tests were made over the frequency range of 30MHz to 25 GHz, 10 times the highest fundamental frequency.

The EUT was rotated through 360° and the receive antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. For frequencies below 1000MHz, quasi-peak measurements were made using a resolution bandwidth RBW of 120 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000MHz, peak and average measurements were made with RBW and VBW of 1 MHz and 3 MHz respectively. The average emissions were further corrected by applying the duty cycle correction of the EUT for comparison to the average limit.

Each emission found to be in a restricted band was compared to the applicable radiated emission limits.

The EUT was evaluated in X, Y and Z orientations.

7.5.3.2 Duty Cycle Correction

For average radiated measurements, using a 15.4% duty cycle, the measured level was reduced by a factor -16.25dB. The duty cycle correction factor is determined using the formula: 20log (15.4/100) = -16.25dB.

A detailed analysis of the duty cycle timing is provided in the Theory of Operation accompanying this report.

7.5.3.3 Measurement Results

Radiated spurious emissions found in the band of 30MHz to 25GHz are reported in the tables below.

Table 7.5.3.3-1: Radiated Spurious Emissions Tabulated Data – X Orientation

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel										
4810	50.02	39.67	H	2.06	52.08	25.48	74.0	54.0	21.9	28.5
4810	56.03	48.21	V	2.06	58.09	34.02	74.0	54.0	15.9	20.0
Middle Channel										
4880	54.91	46.56	H	2.22	57.13	32.53	74.0	54.0	16.9	21.5
4880	50.21	40.51	V	2.22	52.43	26.48	74.0	54.0	21.6	27.5
High Channel										
4960	53.37	44.70	H	2.40	55.77	30.85	74.0	54.0	18.2	23.2
4960	55.93	47.85	V	2.40	58.33	34.00	74.0	54.0	15.7	20.0

Table 7.5.3.3-2: Radiated Spurious Emissions Tabulated Data – Y Orientation

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel										
4810	51.47	42.16	H	2.06	53.53	27.97	74.0	54.0	20.5	26.0
4810	53.31	44.30	V	2.06	55.37	30.11	74.0	54.0	18.6	23.9
Middle Channel										
4880	51.16	42.09	H	2.22	53.38	28.06	74.0	54.0	20.6	25.9
4880	53.86	45.47	V	2.22	56.08	31.44	74.0	54.0	17.9	22.6
High Channel										
4960	51.10	42.47	H	2.40	53.50	28.62	74.0	54.0	20.5	25.4
4960	54.20	45.49	V	2.40	56.60	31.64	74.0	54.0	17.4	22.4

Table 7.5.3.3-3: Radiated Spurious Emissions Tabulated Data – Z Orientation

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel										
4810	52.31	42.57	H	2.06	54.37	28.38	74.0	54.0	19.6	25.6
4810	55.29	47.40	V	2.06	57.35	33.21	74.0	54.0	16.7	20.8
Middle Channel										
4880	53.13	44.37	H	2.22	55.35	30.34	74.0	54.0	18.7	23.7
4880	54.25	46.20	V	2.22	56.47	32.17	74.0	54.0	17.5	21.8
7320	48.11	37.16	V	7.81	55.92	28.72	74.0	54.0	18.1	25.3
High Channel										
4960	52.70	43.94	H	2.40	55.10	30.09	74.0	54.0	18.9	23.9
4960	54.10	45.72	V	2.40	56.50	31.87	74.0	54.0	17.5	22.1

7.5.3.4 Sample Calculation:

$R_C = R_U + CF_T$

Where:

CF_T = Total Correction Factor (AF+CA+AG)-DC (Average Measurements Only)
R_U = Uncorrected Reading
R_C = Corrected Level
AF = Antenna Factor
CA = Cable Attenuation
AG = Amplifier Gain
DC = Duty Cycle Correction Factor

Example Calculation: Peak – X Position

Corrected Level: 50.02 + 2.06 = 52.08dBuV/m
Margin: 74dBuV/m – 52.08dBuV/m = 21.9dB

Example Calculation: Average – X Position

Corrected Level: 39.67 + 2.06 - 16.25 = 25.48dBuV
Margin: 54dBuV – 25.48dBuV = 28.5dB

7.6 Peak Power Spectral Density- FCC Section 15.247(e) IC: RSS-210 A8.2(b)

7.6.1 Measurement Procedure

The power spectral density was measured in accordance with the FCC KDB Publication No. 558074 "Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)". The emission peaks within the pass band were located and zoomed in on. The spectrum analyzer RBW was set to 3 kHz and VBW 10 kHz. Span was adjusted to 200 kHz and the sweep time was calculated to be 68s ~ (Span/3 kHz).

7.6.2 Measurement Results

Results are shown below in table 7.6.2-1 and figures 7.6.2-1 – 7.6.2-3:

Table 7.6.2-1: Peak Power Spectral Density

Frequency (MHz)	PSD Level (dBm)
2405	-13.81
2440	-13.72
2480	-14.03

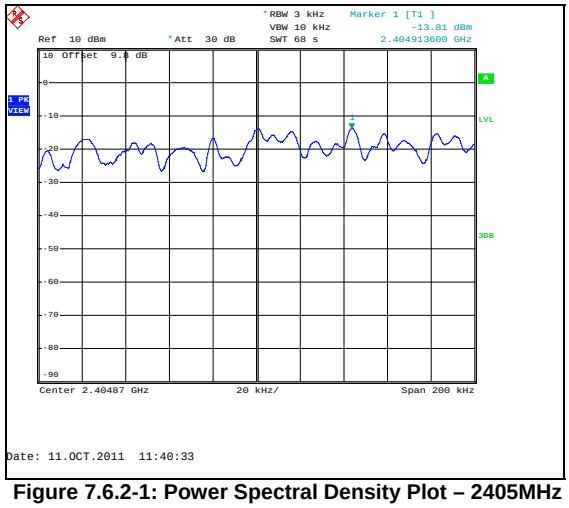


Figure 7.6.2-1: Power Spectral Density Plot – 2405MHz

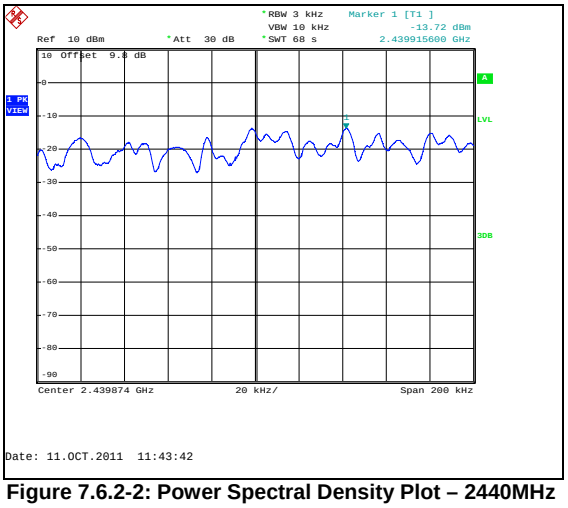


Figure 7.6.2-2: Power Spectral Density Plot – 2440MHz

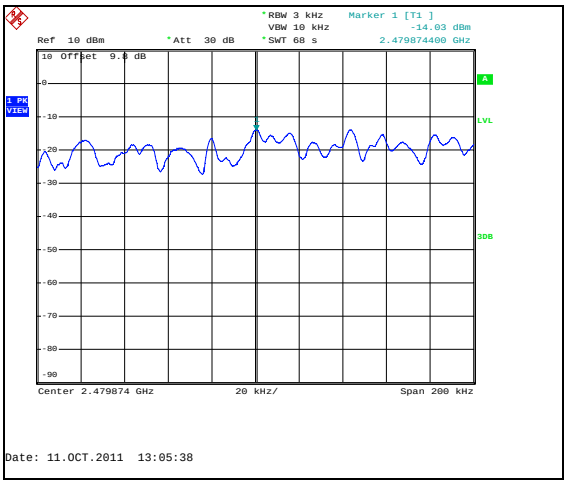


Figure 7.6.2-3: Power Spectral Density Plot – 2480MHz

8 CONCLUSION

In the opinion of ACS, Inc. the HB Hard Tag, manufactured by Alpha - High Theft Solutions meets the requirements of FCC Part 15 subpart C and Industry Canada's Radio Standards Specification RSS-210.

END REPORT