Excellence in Compliance Testing

FCC Part 15.249
Transmitter Certification

Test Report

FCC ID: U22GSEWSC

FCC Rule Part: 15.249

ACS Report Number: 07-0017-15C

Manufacturer: Convia – A Herman Miller Company
Model: Wireless Switch Coordinator

Test Begin Date: February 7, 2007
Test End Date: February 9, 2007

Report Issue Date: March 27, 2007

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 200612-0

This report is not be used to claim certification, approval, or endorsement by NVLAP, NIST or any government agency.

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This report contains 16 pages

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1.0 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.

1.2 Product Description

1.2.1 General

The Wireless Switch Coordinator acts as the network interface for the Convia RF Wireless Switch. It provides a gateway to the Convia NET communications network and allows the Convia RF Wireless Switch to be an active participant on the network.

Detailed photographs of the EUT are filed separately with this filing.

1.2.2 Intended Use

A key function of the Wireless Switch Coordinator is that it monitors the Convia Net communications network for relevant message commands that apply to the Wireless Switch. This allows the Wireless Switch to connect to the network less frequently and increases battery life.

1.3 Test Methodology and Considerations

The model being used for compliance testing contains special test firmware that allows the unit to transmit continuously. All other transmit parameters, such as the RF power setting, are identical to the final product. When operating in the special test mode, the duty cycle is continuous (100%). The transmitter operates at its full data rate of 250 kbps and sends random data.

2.0 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

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. In addition, ACS is compliant to ISO 17025 as certified by the National Institute of Standards and Technology under their National Voluntary Laboratory Accreditation Program. The following certification numbers have been issued in recognition of these accreditations and certifications:

FCC Registration Number: 89450
Industry Canada Lab Code: IC 4175
VCCI Member Number: 1831

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

NVLAP Lab Code: 200612-0

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:

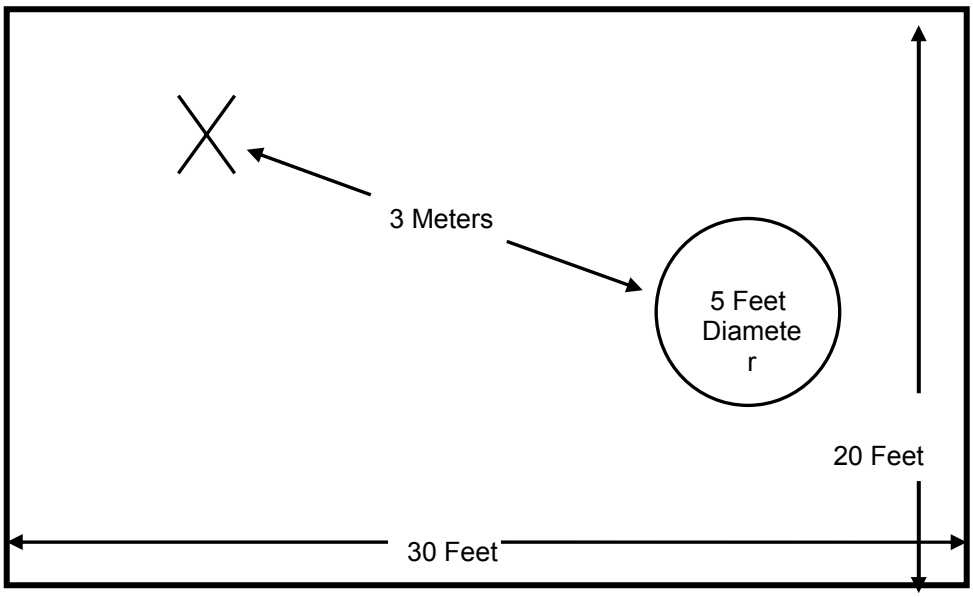

Figure 2.3-1: Semi-Anechoic Chamber Test Site

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:

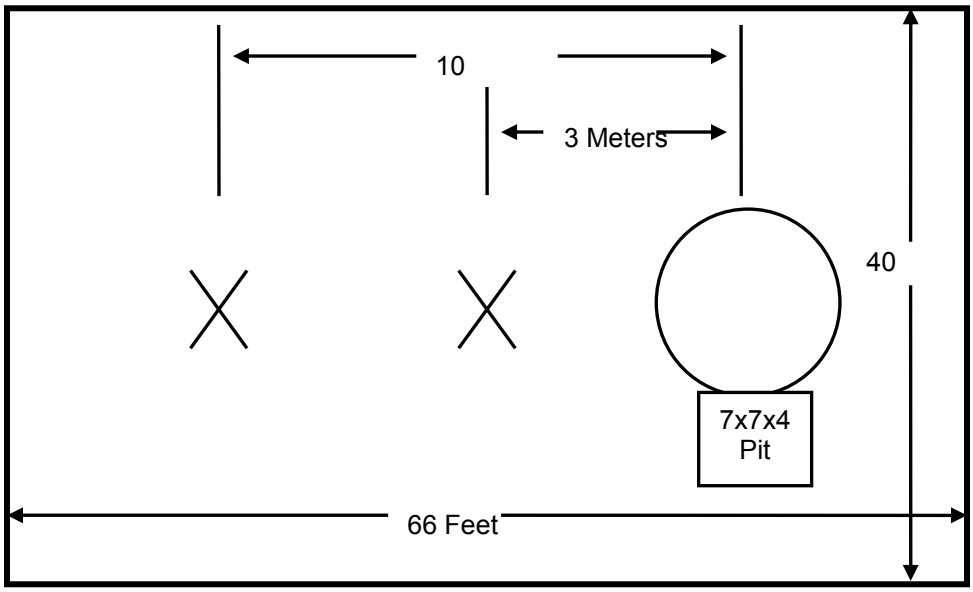

Figure 2.3-2: Open Area Test Site

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:

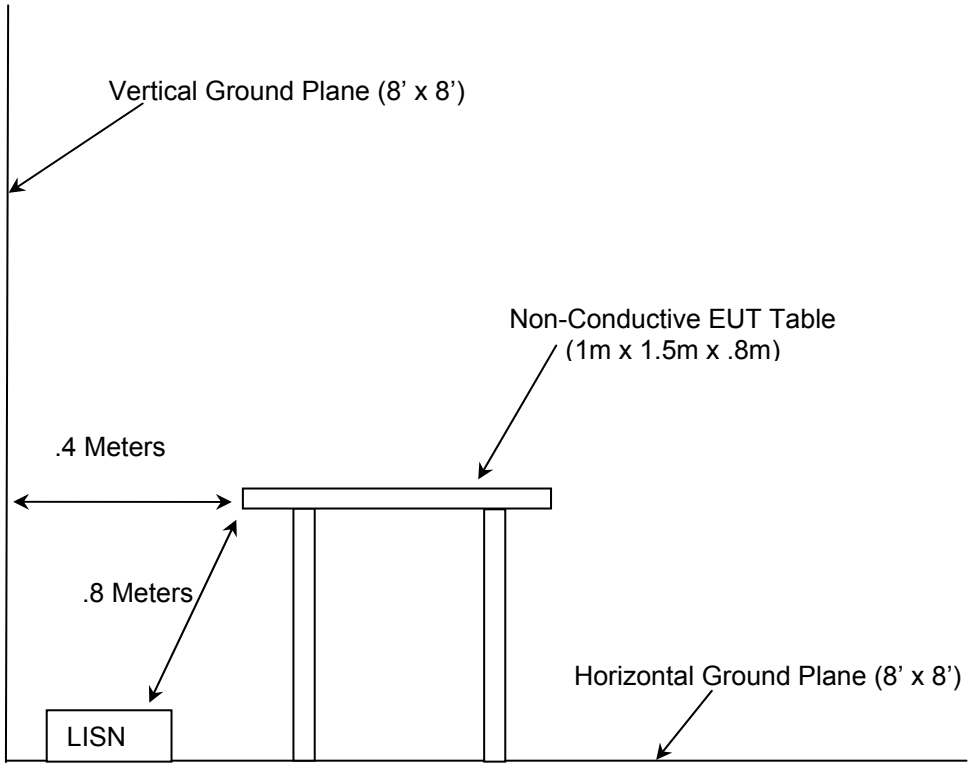

Figure 2.4-1: AC Mains Conducted EMI Site

3.0 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, 2006
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2006

4.0 LIST OF TEST EQUIPMENT

All test equipment used for regulatory testing is calibrated yearly or according to manufacturer's specifications.

Table 4-1: Test Equipment

Equipment Calibration Information					
ACS#	**Mfg.**	**Eq. type**	**Model**	**S/N**	**Cal. Due**
☒ 25	Chase	Bi-Log Antenna	CBL6111	1043	5/30/07
☒ 193	ACS	Cable Set	OATS cable Set	0193	2/16/08
☒ 213	Test Equipment Corp.	Pre-Amplifier	PA-102	44927	2/28/07
☒ 22	Agilent	Pre-Amplifier	8449B	3008A00526	5/06/07
☒ 73	Agilent	Pre-Amplifier	8447D	272A05624	5/18/07
☒ 30	Spectrum Technologies	Horn Antenna	DRH-0118	970102	5/12/07
☒ 333	ETS-Lindgren	Horn Antenna	3160-09	00049404	9/11/07
☒ 282	Microwave Circuits	High Pass Filter	H2G020G4	74541	3/10/07
☒ 1	Rohde & Schwarz	Receiver Display	804.8932.52	833771/007	3/01/07
☒ 2	Rohde & Schwarz	ESMI Receiver	1032.5640.53	839587/003	3/01/07
☒ NA	Agilent	Spectrum Analyzer	E7405A	MY42000128	2/28/07
☒ 167	ACS	Chamber EMI Cable Set	RG6	167	1/05/08
☒ 335	Suhner	HF RF Cable	SF-102A	882/2A	08/29/07
☒ 335	Suhner	HF RF Cable	SF-102A	1077/2A	12/19/07
☒ 290	Florida RF Labs	HF RF Cable	SMSE-200-72.0-SMRE	NA	5/08/07
☒ 291	Florida RF Labs	HF RF Cable	SMRE-200W-12.0-SMRE	NA	5/08/07
☒ 292	Florida RF Labs	HF RF Cable	SMR-280AW-480.0-SMR	NA	5/24/07

5.0 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number	FCC ID
1	Plug-In Class 2 Transformer	Jameco	DDU075110	DC7511F21	NA

6.0 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

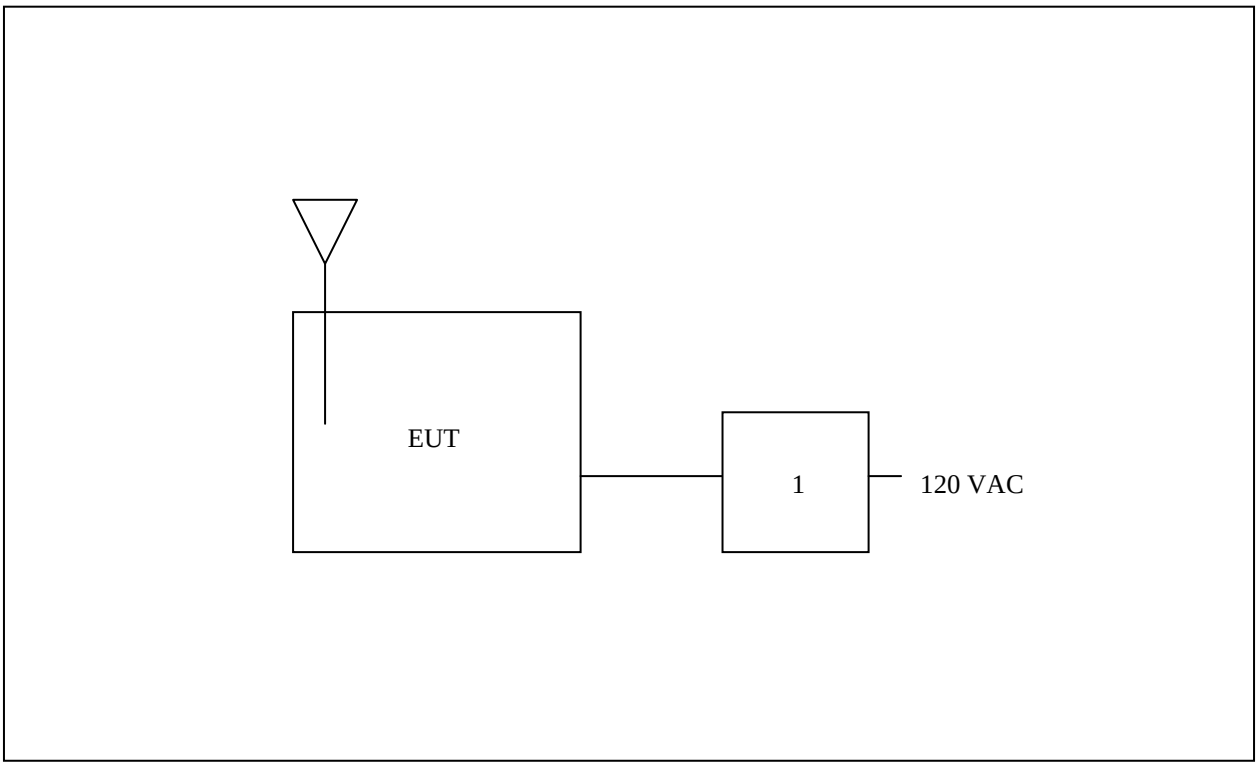

Figure 6-1: EUT Test Setup

*See Test Setup photographs for additional detail.

7.0 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 product uses a half wave dipole, connected to the PCB through a Reverse Polarity SMA connector. The antenna has 2.2 dBi gain.

7.2 Power Line Conducted Emissions - FCC Section 15.207

7.2.1 Measurement Procedure

ANSI C63.4 sections 6 and 7 were the guiding documents for this evaluation. Conducted emissions were performed from 150kHz to 30MHz with the spectrum analyzer's resolution bandwidth set to 9kHz and the video bandwidth set to 30kHz. The calculation for the conducted emissions is as follows:

Corrected Reading = Analyzer Reading + LISN Loss + Cable Loss
Margin = Applicable Limit - Corrected Reading

7.2.2 Measurement Results

Results of the test are shown below in and Tables 7.2-1.

Table 7.2-1: Conducted EMI Results

Frequency (MHz)	Uncorrected Reading (dBuV)		Total Correction Factor (dB)	Corrected Level (dBuV)		Limit (dBuV)		Margin (dB)	
	Quasi-Peak	Average		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
Line 1									
0.16	30.4	5.1	9.80	40.20	14.90	65.46	55.46	25.3	40.6
0.18	29.9	11.7	9.80	39.70	21.50	64.49	54.49	24.8	33.0
0.24	27.1	7.2	9.80	36.90	17.00	62.10	52.10	25.2	35.1
0.48	20	0.8	9.80	29.80	10.60	56.34	46.34	26.5	35.7
5.57	2.4	-1.9	9.80	12.20	7.90	60.00	50.00	47.8	42.1
27.16	7.2	4.1	10.20	17.40	14.30	60.00	50.00	42.6	35.7
Line 2									
0.16	31.1	5.1	9.80	40.90	14.90	65.46	55.46	24.6	40.6
0.24	28	7.2	9.80	37.80	17.00	62.10	52.10	24.3	35.1
0.36	24.3	2.4	9.80	34.10	12.20	58.73	48.73	24.6	36.5
0.47	21.6	1.2	9.80	31.40	11.00	56.51	46.51	25.1	35.5
0.63	18.7	0.6	9.80	28.50	10.40	56.00	46.00	27.5	35.6
5.51	4.9	-1.9	9.81	14.71	7.91	60.00	50.00	45.3	42.1

7.3 Radiated Emissions - FCC Section 15.109(Unintentional Radiation)

7.3.1 Test Methodology

Radiated emissions tests were performed over the frequency range of 30MHz to 12.5GHz. Measurements of the radiated field strength were made at a distance of 3m from the boundary of the equipment under test (EUT) and the receiving antenna. The 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, average and peak measurements were made using an RBW of 1 MHz and a VBW of 3 MHz.

7.3.2 Test Results

Results of the test are given in Table 7.3-1 below:

Table 7.3-1 – Radiated Emissions (Unintentional)

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
30	---------	20.19	H	-7.00	---------	13.19	--------	40.0	---------	26.81
44.01	---------	20.32	H	-13.82	---------	6.50	--------	40.0	---------	33.50
115.14	---------	20.63	V	-13.40	---------	7.23	--------	43.5	---------	36.27
160.41	---------	24.26	V	-14.12	---------	10.14	--------	43.5	---------	33.36
240.16	---------	25.63	H	-12.29	---------	13.34	--------	46.0	---------	32.66
321	---------	35.20	H	-9.77	---------	25.43	--------	46.0	---------	20.57
352.25	---------	33.88	H	-8.21	---------	25.67	--------	46.0	---------	20.33
448.17	---------	38.50	H	-7.15	---------	31.35	--------	46.0	---------	14.65
641.1	---------	33.09	H	-2.77	---------	30.32	--------	46.0	---------	15.68
943.95	---------	21.82	V	2.82	---------	24.64	--------	46.0	---------	21.36

* Note: All emissions above 943.95 MHz were attenuated below the permissible limit.

7.4 Fundamental Field Strength – FCC Section 15.249(a)

7.4.1 Test Methodology

Radiated emissions tests were made on the 3 channels in the 2400MHz to 2483.5MHz frequency range, the low channel being 2410 MHz, the middle channel being 2440 MHz, and the high channel being 2470 MHz.

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. The limits are specified as average limits however, as shown in 15.35, whenever average limits are specified there is a limit of the peak emission which is 20dB above the maximum permitted average limit. Average measurements were made using an RBW of 1 MHz and a VBW of 10 Hz and peak measurements were made with RBW of 1 MHz and a VBW of 1 MHz.

7.4.2 Duty Cycle Correction

For average radiated measurements, the measured level was reduced by a factor 35.91dB to account for the duty cycle of the EUT. The duty cycle correction factor is determined using the formula:
20log (.016) = -35.91 dB.

See Theory of Operation for further detail.

7.4.3 Test Results

Results are shown below in table 7.4.3-1 below:

Table 7.4.3-1: Fundamental Field Strength

Frequency (MHz)	Level (dBuV)		Correction Factors	Duty Cycle Correction	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(dB)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
2410	106.75	102.84	-0.10	-35.91	106.65	66.83	114.0	94.0	7.35	27.17
2440	107.05	103.32	0.01	-35.91	107.06	67.42	114.0	94.0	6.92	26.58
2470	107.25	103.57	0.11	-35.91	107.36	67.77	114.0	94.0	6.64	26.23

7.5 Radiated Spurious Emissions – FCC Section 15.249(a)

7.5.1 Test Methodology

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, average measurements were made using an RBW of 1 MHz and a VBW of 10 Hz and peak measurements were made with RBW of 1 MHz and a VBW of 1 MHz.

See section 7.4.2 for duty cycle correction.

7.5.2 Test Results

Results are shown below in Table 7.5.2-1.

Table 7.5.2-1 - Radiated Spurious Emissions

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Duty Cycle Correction	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Spurious Emissions - Low Channel											
4820	56.41	46.63	V	7.95	-35.91	64.36	18.67	74.0	54.0	9.64	35.33
Spurious Emissions - Mid. Channel											
4880	49.21	36.61	H	7.98	-35.91	57.19	8.68	74.0	54.0	16.81	45.32
4880	57.77	46.62	V	8.15	-35.91	65.92	18.86	74.0	54.0	8.08	35.14
Spurious Emissions - High Channel											
No Spurious Emissions Detected above Noise Floor											

*The magnitude of all emissions not reported were below the noise floor of the measurement system.

7.5.3 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:
Corrected Level: 49.21 + 7.98 = 57.19dBuV
Margin: 74dBuV – 57.19dBuV = 16.81dB

AVERAGE:
Corrected Level: 36.61 + 7.98 -35.91= 8.68dBuV
Margin: 54dBuV – 8.68dBuV = 45.32dB

7.6 20dB Bandwidth FCC Section 15.215

7.6.1 Test Methodology

The spectrum analyzer span was set to 2 to 3 times the estimated 20 dB bandwidth of the emission. The RBW was to ≥ 1% of the estimated 20 dB bandwidth. The trace was set to max hold with a peak detector active. The Delta function of the analyzer was utilized to determine the 20 dB bandwidth of the emission. The span and RBW were examined and re-adjusted if necessary to meet the requirements of 2 to 3 times the 20 bandwidth for the span and ≥ 1% of the 20 dB bandwidth for the RBW.

7.6.2 Test Results

The maximum 20dB bandwidth was found to be approximately 2.650 MHz. Results are shown below in Table 7.6.2-1 and Figures 7.6.2-1 through 7.6.2-3.

Table 7.6.2-1

Frequency (MHz)	20dB Bandwidth (MHz)
2410	2.650
2440	2.625
2470	2.650

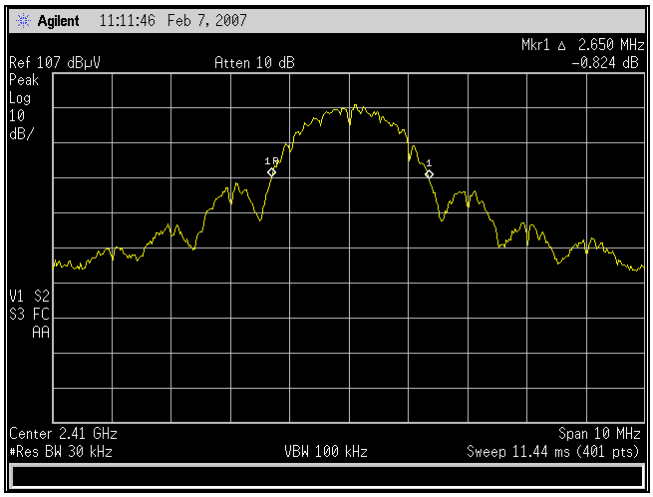

Figure 7.6.2-1: 20dB Bandwidth Low Channel

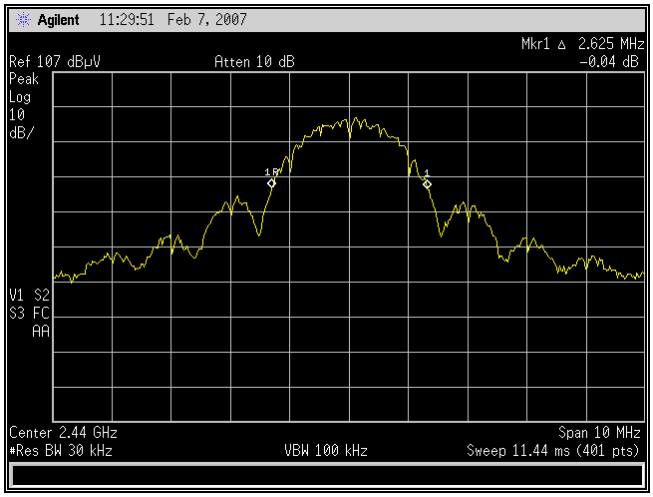

Figure 7.6.2-2: 20dB Bandwidth Mid Channel

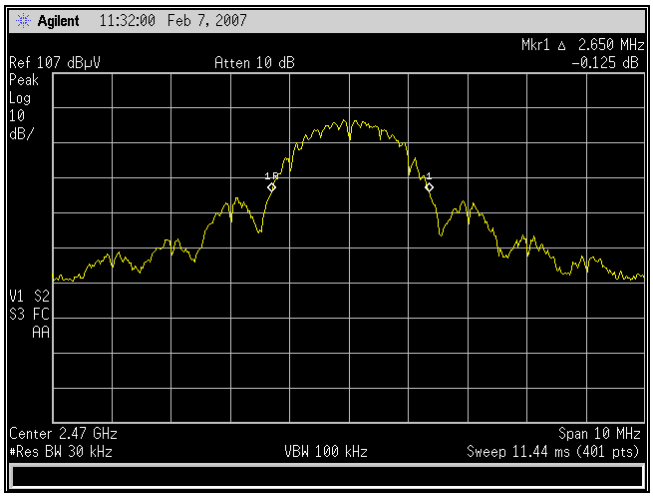

Figure 7.6.2-3: 20dB Bandwidth High Channel

7.7 Band-Edge Compliance and Spurious Emissions - FCC Section 15.249(d)

7.7.1 Test Methodology

The EUT was investigated at the low and high channels of operation to determine band-edge compliance. Band-edge compliance for the lower and upper band-edge was determined using the radiated mark-delta method as outlined in FCC DA 00-705. The radiated field strength of the fundamental emission was first determined and then the mark-delta method was used to determine the field strength of the band-edge emissions as compared to the emission limits of 15.209.

7.7.2 Test Results

Band-edge compliance is displayed in Tables 7.7.2-1 to 7.7.2-2 and Figures 7.7.2-1 – 7.7.2-2.

Table 7.7.2-1: Lower Band-edge Marker Delta Method

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Fundamental Field Strength (dBuV/m)		Delta-Marker (dB)	Band-edge Field Strength (dBuV/m)		Margin to Limit (dBuV/m) 74 / 54	
	pk	avg	(H/V)	(dB)	pk	avg		pk	avg	pk	avg
Fundamental Frequency											
2410	106.75	102.84	V	-0.10	106.65	66.82	44.1	62.55	22.72	11.45	31.28

Table 7.7.2-2: Upper Band-edge Marker Delta Method

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Fundamental Field Strength (dBuV/m)		Delta-Marker (dB)	Band-edge Field Strength (dBuV/m)		Margin to Limit (dBuV/m) 74 / 54	
	pk	avg	(H/V)	(dB)	pk	avg		pk	avg	pk	avg
Fundamental Frequency											
2470	107.25	103.57	V	0.11	107.36	67.76	49.48	57.88	18.28	16.12	35.72

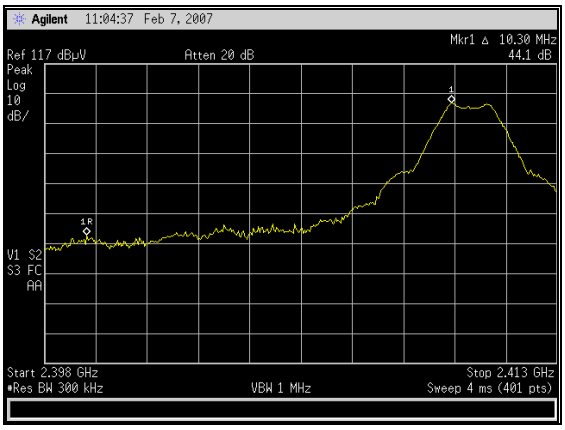

Figure 7.7.2-1: Lower Band-edge

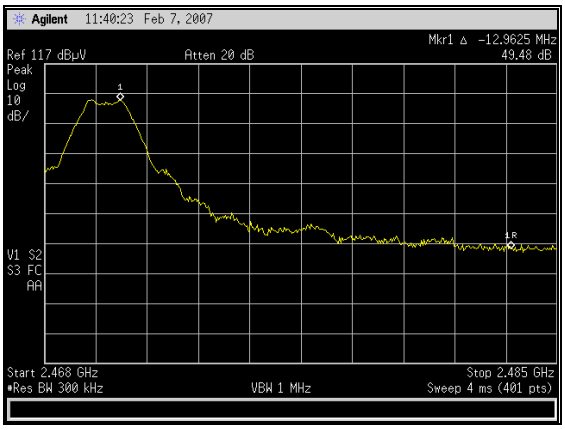

Figure 7.7.2-2: Upper Band-edge

8.0 CONCLUSION

In the opinion of ACS, Inc. the Wireless Switch Coordinator, manufactured by Convia – A Herman Miller Company meets the requirements of FCC Part 15 subpart C.

END REPORT