Excellence in Compliance Testing

Certification Test Report

FCC ID: V2V-WMR900

FCC Rule Part: 15.247

ACS Report Number 09-0231-15C

Manufacturer: **LigoWave LLC**
Model(s): **WMR900**

Test Begin Date: June 23, 2009
Test End Date: July 2, 2009

Report Issue Date: July 6, 2009

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 12 pages

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Test Setup Photographs
RF Exposure

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 for a Class II Permissive Change to add four additional antennas types.

1.2 Product Description

1.2.1 General

LigoPTP products are designed to provide superior performance at long range distances. With a proprietary wireless driver that was written for the sole purpose of optimizing wireless point to point links, one can achieve much higher throughput, especially at longer links, than standards based products.

Manufacturer Information:
LigoWave LLC
1440 Dutch Valley Place
Suite 1155
Atlanta, GA 30324

Test Sample Serial Number(s):
00156D943B9B

Antennas Evaluated:
Hyperlink Technologies, Model:HG918G, Grid Reflector Antenna 18dBi Gain
Hyperlink Technologies, Model:HG908U, Omnidirectional Antenna 8dBi Gain
Hyperlink Technologies, Model:HG913Y, Yagi Antenna 13dBi Gain
ARC Wireless Solutions, Model:ARC-IA0913B01 Panel Antenna 13dBi Gain

Test Sample Condition:
The test sample was provided in good working condition.

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

1.2.2 Intended Use

LigoPTP devices provide high throughput, Point-to-Point connectivity for backhaul applications on a variety of frequencies.

1.3 Test Methodology and Considerations

Four additional antennas types are added in this Class II Permissive Change, an Omni, Yagi, Panel, and Grid; with antenna gains of 8, 13, 12.5, and 18 dBi respectively. Based on the EIRP limit in 15.247 of 36 dBm, where necessary the conducted gain of the device has been lowered to account for the higher gain antennas in order to keep the total EIRP below the 36 dBm limit.

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/IEC 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: 894540
Industry Canada Lab Code: IC 4175A
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:

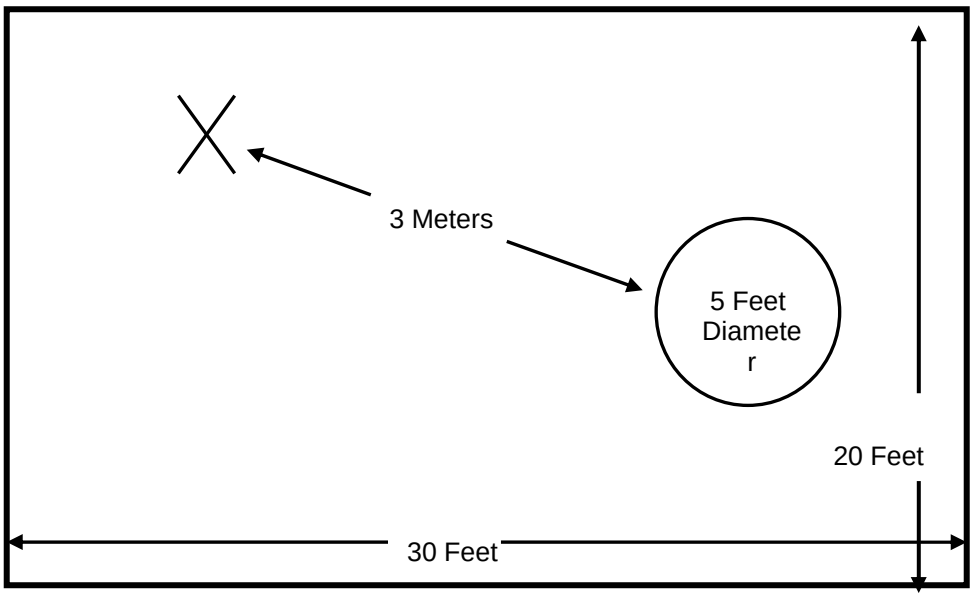

Figure 2.3-1: Semi-Anechoic Chamber Test Site

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:

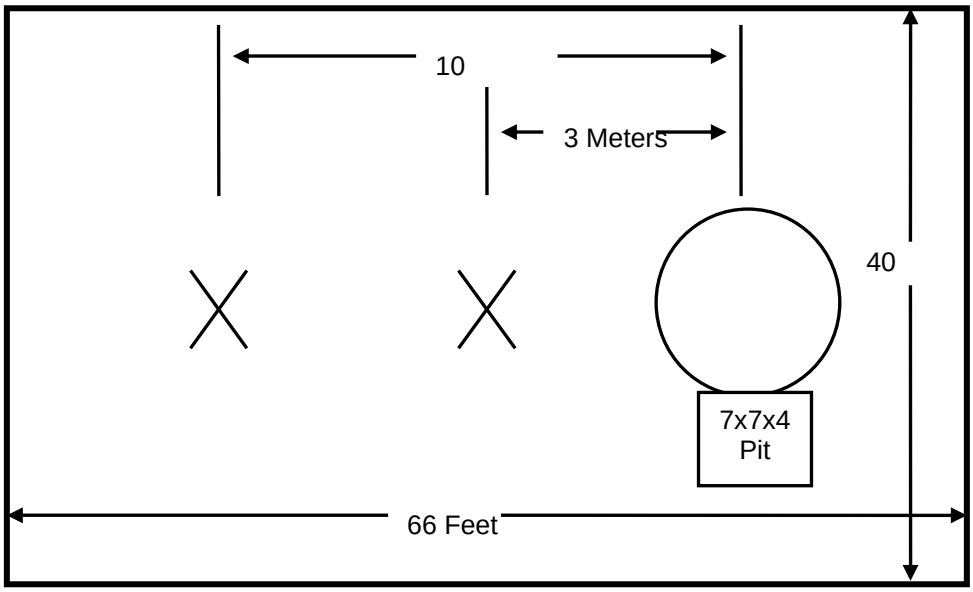

Figure 2.3-2: Open Area Test Site

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:

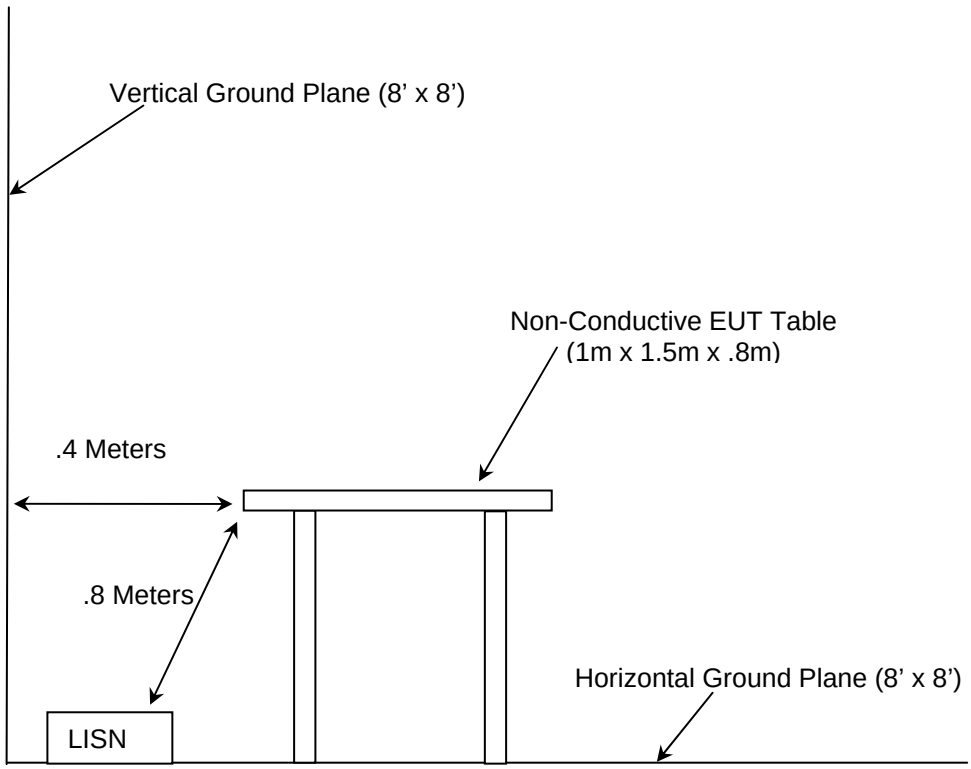

Figure 2.4-1: AC Mains Conducted EMI Site

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, 2009
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2009
- FCC OET Bulletin 65 Appendix C - Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields, 2001

4.0 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

Equipment Calibration Information					
ACS#	**Mfg.**	**Eq. type**	**Model**	**S/N**	**Cal. Due**
25	Chase	Antennas	CBL6111	1043	08/22/2009
283	Rohde & Schwarz	Spectrum Analyzers	FSP40	1000033	09/19/2009
291	Florida RF Cables	Cables	SMRE-200W-12.0-SMRE	None	11/24/2009 (Note1)
292	Florida RF Cables	Cables	SMR-290AW-480.0-SMR	None	11/24/2009 (Note1)
338	Hewlett Packard	Amplifiers	8449B	3008A01111	10/22/2009
422	Florida RF	Cables	SMS-200AW-72.0-SMR	805	02/05/2010 (Note1)
340	Aeroflex/Weinschel	Attenuators	AS-20	7136	10/22/2009 (Note2)
331	Microwave Circiuts	Filters	H1G513G1	31417	7/28/2009
30	Spectrum Technologies	Antennas	DRH-0118	970102	05/08/2010
73	Agilent	Amplifier	8447D	2727A05624	01/05/2010

Note1: Items characterized on an annual cycle. The date shown indicates the next characterization due date.
Note2: Items verified on an annual cycle. The date shown indicates the next verification due date.

5.0 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number	FCC ID
1	EUT	LigoWave LLC	WMR900	00156D943B9B	V2V-WMR900
2	Computer	Dell	Latitude D810	C5725 A00	NA
3	Power Supply	Dell	ADP-90AH B	CN-0C8023-48661-5AN-BFUL A03	NA
4	Extender Board	VYTEK	STCBMPI3	399	NA

6.0 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

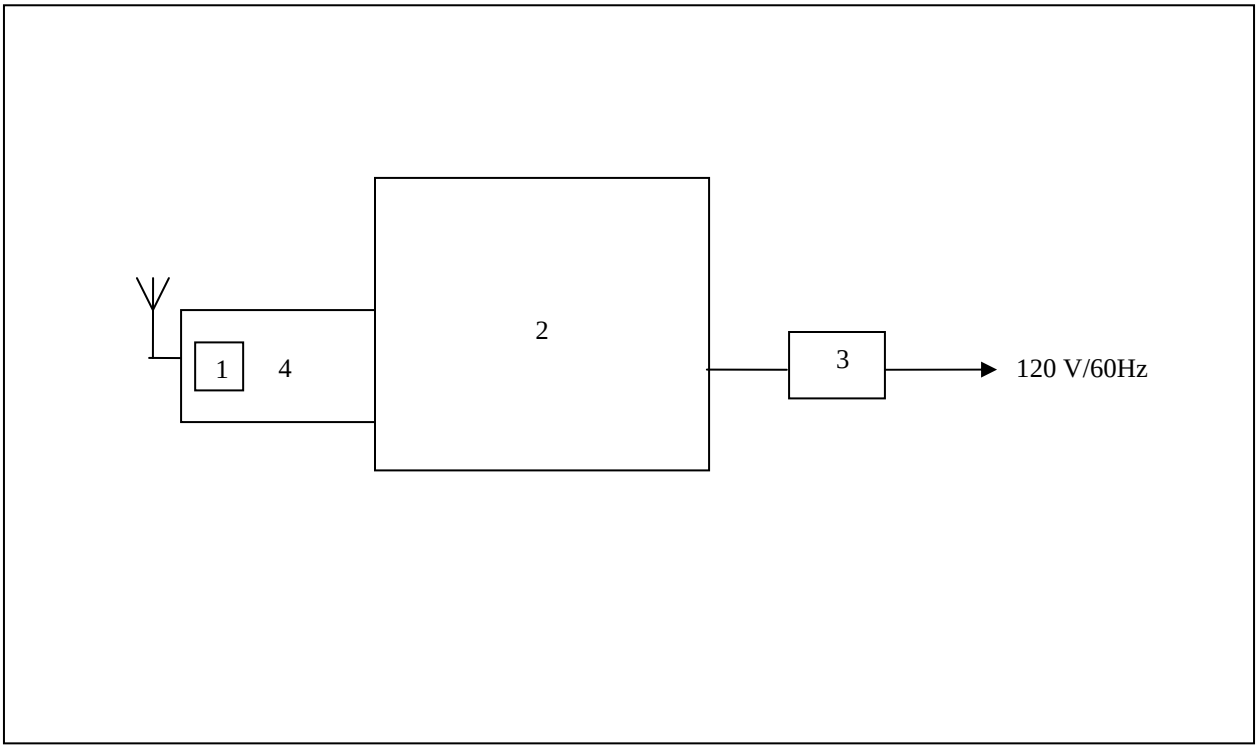

Figure 6-1: EUT Test Setup

*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 module utilizes an MMX connector which satisfies the requirement of 15.203.

7.2 Peak Output Power Requirement - FCC Section 15.247(b)(3)

7.2.1 Test Methodology

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 Power Meter.

Data was collected such that the EUT maintained compliance with the 36dBm EIRP limit and passed radiated emissions.

7.2.2 Test Results

Results are shown below in Table 7.2-1.

Table 7.2-1: Peak Output Power

Antenna	Frequency [MHz]	Measured Power [dBm]
Omni	907	25.68
	917	25.75
	922	25.76
Panel	907	21.8
	917	21.9
	922	21.9
Yagi	907	22.8
	917	22.9
	922	22.9
Grid	907	17.91
	917	17.95
	922	17.91

7.3 Radiated Spurious Emissions - FCC Section 15.205

7.3.1 Test Methodology

Radiated emissions tests were made over the frequency range of 30MHz to 10GHz, 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 are taken with the RBW and VBW were set to 1MHz and 3MHz respectively.

The EUT was caused to generate a continuous modulated carrier signal.

7.3.2 Test Results

Radiated spurious emissions found in the band of 30MHz to 10GHz are reported in Table 7.3-1 through 7.3-4.

Table 7.3-1: Radiated Spurious Emissions – Omni Antenna

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										
2721	65.90	49.20	H	1.13	67.03	50.33	74.0	54.0	6.97	3.67
2721	71.77	47.26	V	1.13	72.90	48.39	74.0	54.0	1.10	5.61
Mid Channel										
2751	65.51	48.62	H	1.23	66.74	49.85	74.0	54.0	7.26	4.15
2751	68.85	51.70	V	1.23	70.08	52.93	74.0	54.0	3.92	1.07
High Channel										
2766	67.26	49.44	H	1.28	68.54	50.72	74.0	54.0	5.46	3.28
2766	68.56	50.76	V	1.28	69.84	52.04	74.0	54.0	4.16	1.96

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

Table 7.3-2: Radiated Spurious Emissions – Panel Antenna

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										
2721	62.45	45.45	H	1.13	63.58	46.58	74.0	54.0	10.42	7.42
2721	68.80	51.39	V	1.13	69.93	52.52	74.0	54.0	4.07	1.48
Mid Channel										
2751	64.82	46.60	H	1.23	66.05	47.83	74.0	54.0	7.95	6.17
2751	64.02	46.12	V	1.23	65.25	47.35	74.0	54.0	8.75	6.65
High Channel										
2766	64.29	45.64	H	1.28	65.57	46.92	74.0	54.0	8.43	7.08
2766	63.57	45.17	V	1.28	64.85	46.45	74.0	54.0	9.15	7.55

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

Table 7.3-3: Radiated Spurious Emissions – Yagi Antenna

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										
2721	55.26	40.48	H	1.13	56.39	41.61	74.0	54.0	17.61	12.39
2721	58.02	43.01	V	1.13	59.15	44.14	74.0	54.0	14.85	9.86
Mid Channel										
2751	56.65	42.65	H	1.23	57.88	43.88	74.0	54.0	16.12	10.12
2751	62.74	47.68	V	1.23	63.97	48.91	74.0	54.0	10.03	5.09
High Channel										
2766	58.90	43.55	H	1.28	60.18	44.83	74.0	54.0	13.82	9.17
2766	61.46	45.99	V	1.28	62.74	47.27	74.0	54.0	11.26	6.73

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

Table 7.3-4: Radiated Spurious Emissions – Grid Antenna

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										
2721	46.76	36.02	V	1.13	47.89	37.15	74.0	54.0	26.11	16.85

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

7.3.3 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: 65.90+ 1.13 = 67.03dBuV/m
Margin: 74dBuV/m – 67.03dBuV/m = 6.97dB

Example Calculation: Average
Corrected Level: 49.20 + 1.13 - 0= 50.33dBuV
Margin: 54dBuV – 50.33dBuV = 3.67dB

8.0 CONCLUSION
In the opinion of ACS, Inc. the WMR900, manufactured by LigoWave, LLC meets the requirements of FCC Part 15 subpart C.

END REPORT