Electromagnetic Compatibility Test Report

Tests Performed on an Ultra-UnderSea Sensor Systems, Inc.

Transmitter, Model 242135

Radiometrics Document RP-6431B

ACCREDITED
Certification # 1495.01

Product Detail: FCC ID: FCC ID: LFFSPRCS1 IC: 6253A-SPRCS1 Equipment type: 2.4 GHz Transmitter
Test Standards: US CFR Title 47, Chapter I, FCC Part 15 Subpart C FCC Part 15 CFR Title 47: 2008 Industry Canada RSS-210, Issue 7: 2007 as required for Category I Equipment This report concerns: Original Grant for Certification FCC Part 15.249

Tests Performed For:	*Test Facility:*
Ultra-UnderSea Sensor Systems, Inc. 4578 East Park 30 Dr. Columbia City, IN 46725	**Radiometrics Midwest Corporation** 12 East Devonwood Romeoville, IL 60446

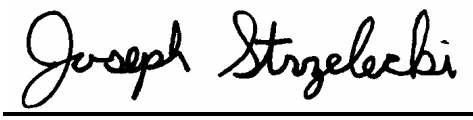
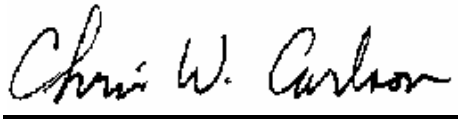
Test Date(s): (Month-Day-Year)
October 10 thru December 30, 2008

Document RP-6431A Revisions:

Rev.	Issue Date	Affected Pages	Revised By
0	January 27, 2009		

Table of Contents

1 ADMINISTRATIVE DATA

Equipment Under Test: A Ultra-UnderSea Sensor Systems, Inc., Transmitter Model: 242135 Serial Number: none This will be referred to as the EUT in this Report	
Date EUT Received at Radiometrics: (Month-Day-Year) October 9, 2008	*Test Date(s): (Month-Day-Year)* October 10 thru December 30, 2008
Test Report Written By: Joseph Strzelecki Senior EMC Engineer	*Test was not Witnessed By Personnel from:* Ultra-UnderSea Sensor Systems, Inc.
Radiometrics' Personnel Responsible for Test:  Joseph Strzelecki Senior EMC Engineer NARTE EMC-000877-NE	*Test Report Approved By*  Chris W. Carlson Director of Engineering NARTE EMC-000921-NE

2 TEST SUMMARY AND RESULTS

The EUT (Equipment Under Test) is a Transmitter, Model 242135, manufactured by Ultra-UnderSea Sensor Systems, Inc.. The detailed test results are presented in a separate section. The following is a summary of the test results.

Transmitter Requirements

Environmental Phenomena	Frequency Range	FCC Section	RSS-210 Section	Test Result
20 dB Bandwidth Test;	2400 to 2483 MHz	15.249	A2.9	Pass
Radiated Emissions	30 MHz to 25 GHz	15.247 d	A2.9	Pass

2.1 RF Exposure Compliance Requirements

Since the ERP is 0.37 mW, The EUT meets the FCC requirement for RF exposure. Since the EUT ERP is less than 200 mW, it is exempt from RSS-102. There are no power level adjustments and the antenna is permanently attached. The detailed calculations for RF Exposure are presented in a separate document.

3 EQUIPMENT UNDER TEST (EUT) DETAILS

3.1 EUT Description

The EUT is a Transmitter, Model 242135, manufactured by Ultra-UnderSea Sensor Systems, Inc. The EUT was in good working condition during the tests, with no known defects.

3.1.1 FCC Section 15.203 & RSS-GEN Antenna Requirements

The antenna is permanently attached to the PCB. The antenna is internal to the EUT and it is not readily available to be modified by the end user. Therefore it meets the 15.203 Requirement.

4 TESTED SYSTEM DETAILS

4.1 Tested System Configuration

The system was configured for testing in a typical fashion. The EUT was placed on an 80-cm high, nonconductive test stand. The testing was performed in conditions as close as possible to installed conditions. Wiring was consistent with manufacturer's recommendations.

The EUT was tested as a stand-alone device. Power was supplied with new batteries.

The identification for all equipment, plus descriptions of all cables used in the tested system, are:

Tested System Configuration List

Item	Description	Type*	Manufacturer	Model Number	Serial Number
1	Transmitter	E	Ultra-UnderSea Sensor Systems, Inc.	242135	none

* Type: E = EUT, P = Peripheral, S = Support Equipment; H = Host Computer

4.2 Special Accessories

No special accessories were used during the tests in order to achieve compliance.

4.3 Equipment Modifications

No modifications were made to the EUT at Radiometrics' test facility in order to comply with the standards listed in this report.

5 TEST SPECIFICATIONS AND RELATED DOCUMENTS

Document	Date	Title
FCC CFR Title 47	2008	Code of Federal Regulations Title 47, Chapter 1, Federal Communications Commission, Part 15 - Radio Frequency Devices
ANSI C63.4-2003	2003	Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
IC RSS-210 Issue 7	2007	Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands) Category I Equipment
IC RSS-Gen Issue 2	2007	General Requirements and Information for the Certification of Radiocommunication Equipment (RSS-Gen)
FCC 913591	2007	Measurement of radiated emissions at the edge of the band for a Part 15 RF Device; FCC interpretation 03/26/2007

The test procedures used are in accordance with Industry Canada RSS-212 and ANSI document C63.4-2003, "Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The specific procedures are described herein. Radiated testing was performed at an antenna to EUT distance of 3 meters. The antenna was raised and lowered from 1 to 4 meters.

6 RADIOMETRICS' TEST FACILITIES

The results of these tests were obtained at Radiometrics Midwest Corp. in Romeoville, Illinois, USA. Radiometrics is accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025: 2005 "General Requirements for the Competence of Calibration and Testing Laboratories". Radiometrics' Lab Code is 121191 and Certification Number is 1495.01. Radiometrics' scope of accreditation includes all of the test methods listed herein. A copy of the accreditation can be accessed on our web site (www.radiomet.com). Radiometrics accreditation status can be verified at A2LA's web site (www.a2la2.org).

The following is a list of shielded enclosures located in Romeoville, Illinois used during the tests:

Chamber A: Is an anechoic chamber that measures 24' L X 12' W X 12' H. The walls and ceiling are fully lined with ferrite absorber tiles. The floor has a 10' x 10' section of ferrite absorber tiles located in the center. Panashield of Rowayton, Connecticut manufactured the chamber. The enclosure is NAMAS certified.

Chamber E: Is a custom made anechoic chamber that measures 52' L X 30' W X 18' H. The walls and ceiling are fully lined with RF absorber. Pro-shield of Collinsville, Oklahoma manufactured the chamber.

Test Station F: Is an area that measures 10' D X 12' W X 10' H. The floor and back wall are metal shielded. This area is used for conducted emissions measurements.

A separate ten-foot long, brass plated, steel ground rod attached via a 6 inch copper braid grounds each of the above chambers. Each enclosure is also equipped with low-pass power line filters.

The FCC has accepted these sites as test site number US1065. The FCC test site Registration Number is 732175. Details of the site characteristics are on file with the Industry Canada as file number IC3124.

A complete list of the test equipment is provided herein. The calibration due dates are indicated on the equipment list. The equipment is calibrated in accordance to ANSI/NCSL Z540-1 with traceability to the National Institute of Standards and Technology (NIST).

7 DEVIATIONS AND EXCLUSIONS FROM THE TEST SPECIFICATIONS

There were no deviations or exclusions from the test specifications. Conducted emissions were not performed as the EUT is battery powered.

8 CERTIFICATION

Radiometrics Midwest Corporation certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specification. The results relate only to the EUT listed herein. Any modifications made to the EUT subsequent to the indicated test date will invalidate the data and void this certification.

9 TEST EQUIPMENT TABLE

RMC ID	Manufacturer	Description	Model No.	Serial No.	Frequency Range	Cal Period	Cal Date
AMP-05	RMC/Celeritek	Pre-amplifier	MW110G	1001	1.0-12GHz	12 Mo.	01/30/08
AMP-20	Avantek	Pre-amplifier	SF8-0652	15221	8-18GHz	12 Mo	01/03/08
AMP-29	HP / Agilent	Amplifier	11975A	2304A00158	2-8 GHz	12 Mo.	10/21/08
AMP-33	Anritsu	20dB pre-amp	MA8610A	M42554	9kHz-2.2GHz	12 Mo.	01/31/08
ANT-13	EMCO	Horn Antenna	3115	2502	1.0-18GHz	24 Mo.	10/24/06 10/22/08
ANT-44	Impossible Machine	Super Log Antenna	SL-20M2G	1002	20-2000MHz	24 Mo.	12/26/07
ANT-48	RMC	Std Gain Horn	HW2020	1001	18-26 GHz	12 Mo.	10/21/08
MXR-02	HP / Agilent	Harmonic Mixer	11970K	2332A00489	18-26.5GHz	12 Mo.	10/21/08
REC-01	Hewlett Packard	Spectrum Analyzer	8566A	2106A02115, 2209A01349	30Hz-22GHz	12 Mo.	10/18/07 10/23/08
REC-03	Anritsu	Spectrum Analyzer	MS2601B	MT94589	0.01-2200MHz	12 Mo.	02/13/08
REC-07	Anritsu	Spectrum Analyzer	MS2601A	MT53067	0.01-2200MHz	12 Mo.	01/11/08
REC-08	Hewlett Packard	Spectrum Analyzer	8566B	2648A13481 2209A01436	30Hz-22GHz	12 Mo.	07/31/07
THM-01	Extech Inst.	Temp/Humid Meter	4465CF	001106557	N/A	24 Mo.	01/18/08

Note: All calibrated equipment is subject to periodic checks.

10 TEST SECTIONS

10.1 Time of Occupancy (Dwell Time)

As required by FCC section 15.35 and RSS-210 section 6.5, the Peak to Average correction factor was calculated.

The transmitter operates for a maximum duration of 64 ms in any 100 ms interval for a 64% maximum duty cycle:

$$\frac{(4ms + 4ms)}{12.5ms} \times \frac{8}{8} = \frac{64ms}{100ms} = 64\%$$

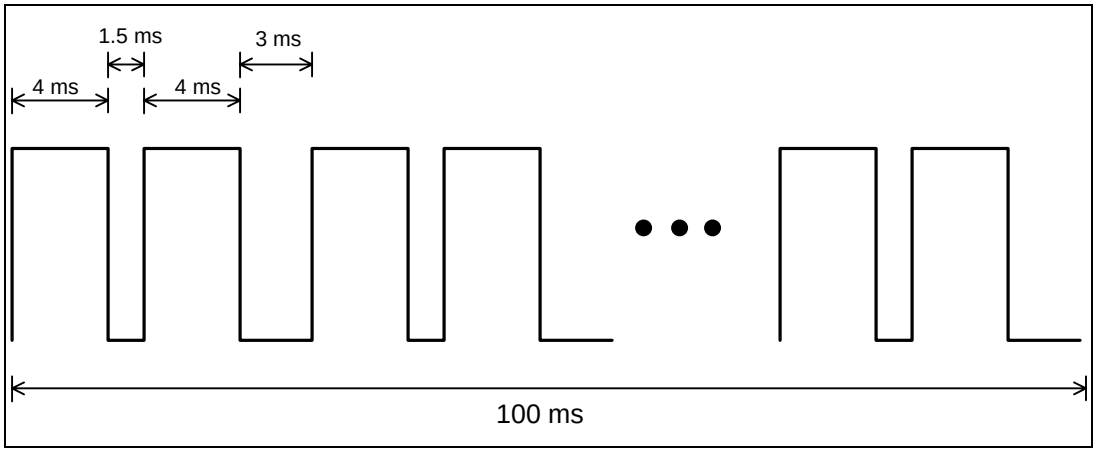


Figure 1. Transmitter Duty Cycle

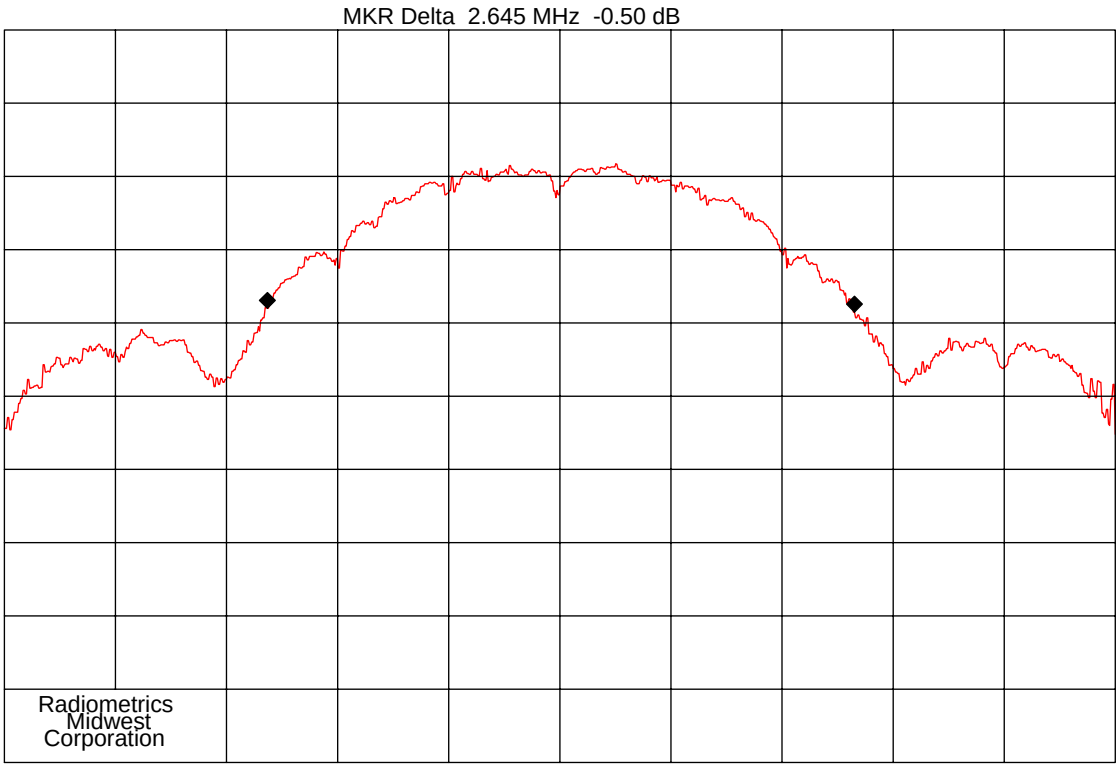
The peak to average factor is 20*Log(64/100) = -3.9 dB

Figure 2. Duty Cycle Plot

10.2 Occupied Bandwidth (20 dB)

The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation. The EUT was transmitting at its maximum data rate. The trace was allowed to stabilize.

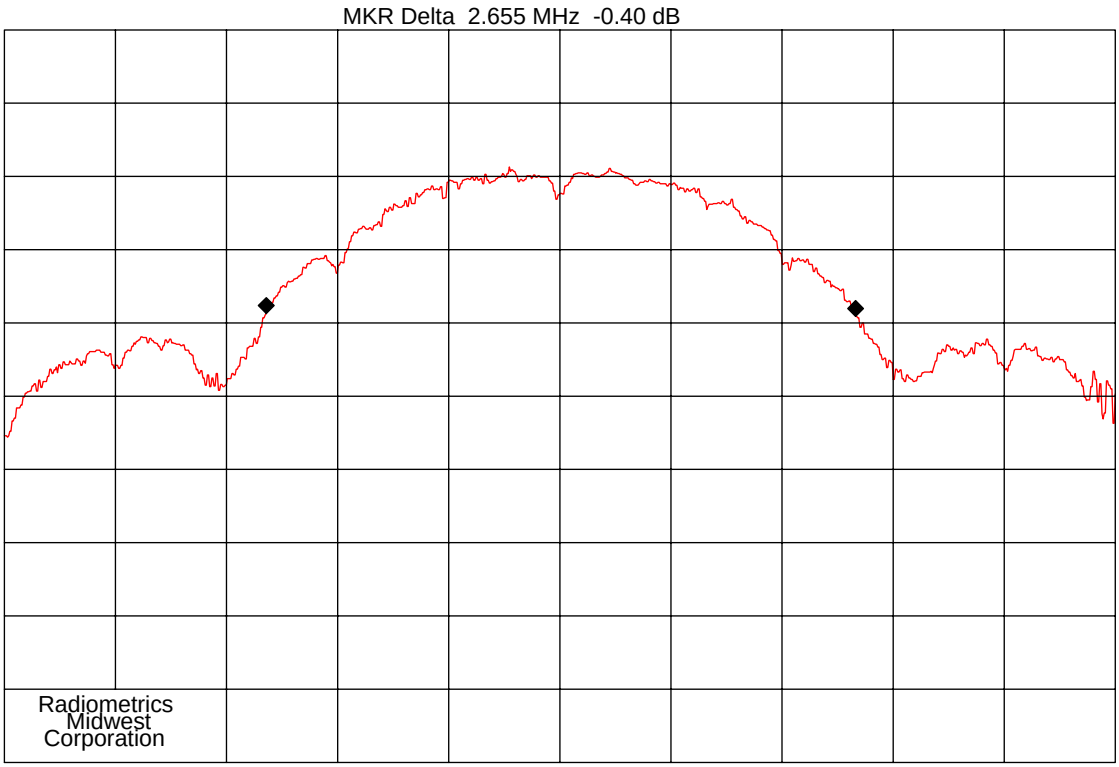
The marker-to-peak function was set to the peak of the emission. Then the marker-delta function was used to measure 20 dB down one side of the emission. The marker-delta function was reset and then moved to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth of the emission.



COMPANY : InDesign
CENTER 2.480 00 GHz
RES BW 100 kHz
10 dB/
NOTES : 20 dB, Occupied Bandwidth

ITEM : RCS
REF 97.0 dBuV
VBW 300 kHz
TIME : 13:10

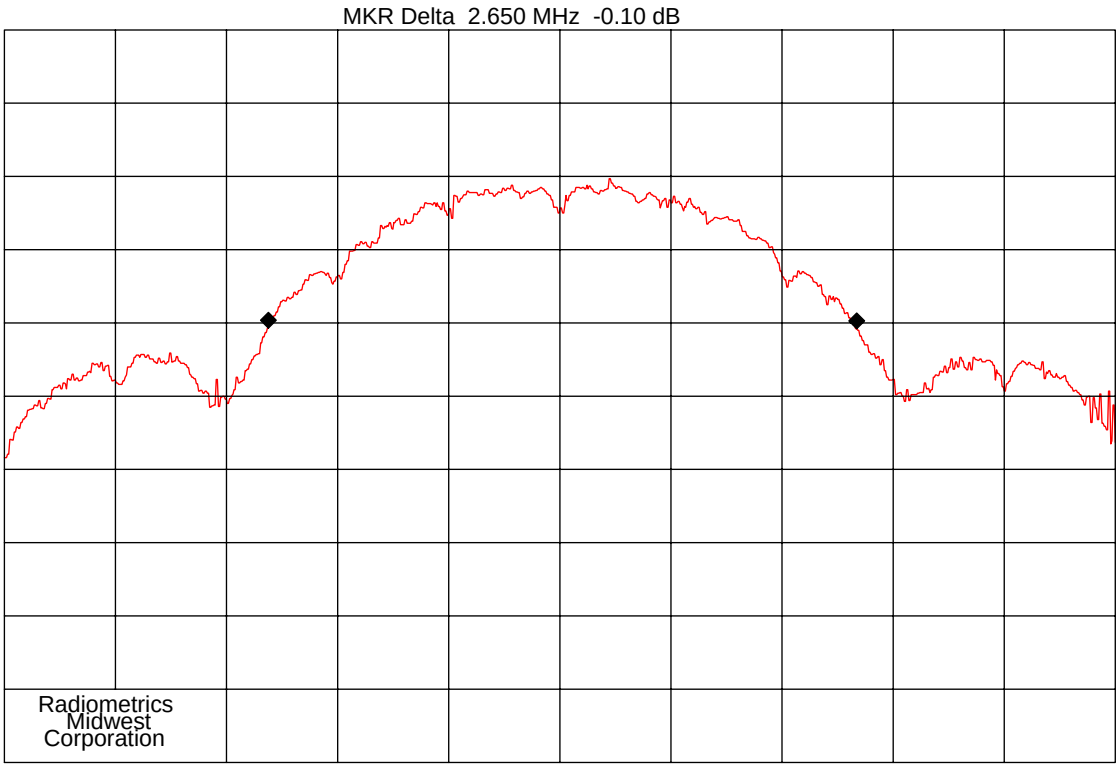
DATE : 12-30-2008
SPAN 5.00 MHz
ATTEN 10 dB
SWP 20.0 msec



COMPANY : InDesign
CENTER 2.440 00 GHz
RES BW 100 kHz
10 dB/
NOTES : 20 dB, Occupied Bandwidth

ITEM : RCS
REF 97.0 dBuV
VBW 300 kHz
TIME : 13:06

DATE : 12-30-2008
SPAN 5.00 MHz
ATTEN 10 dB
SWP 20.0 msec



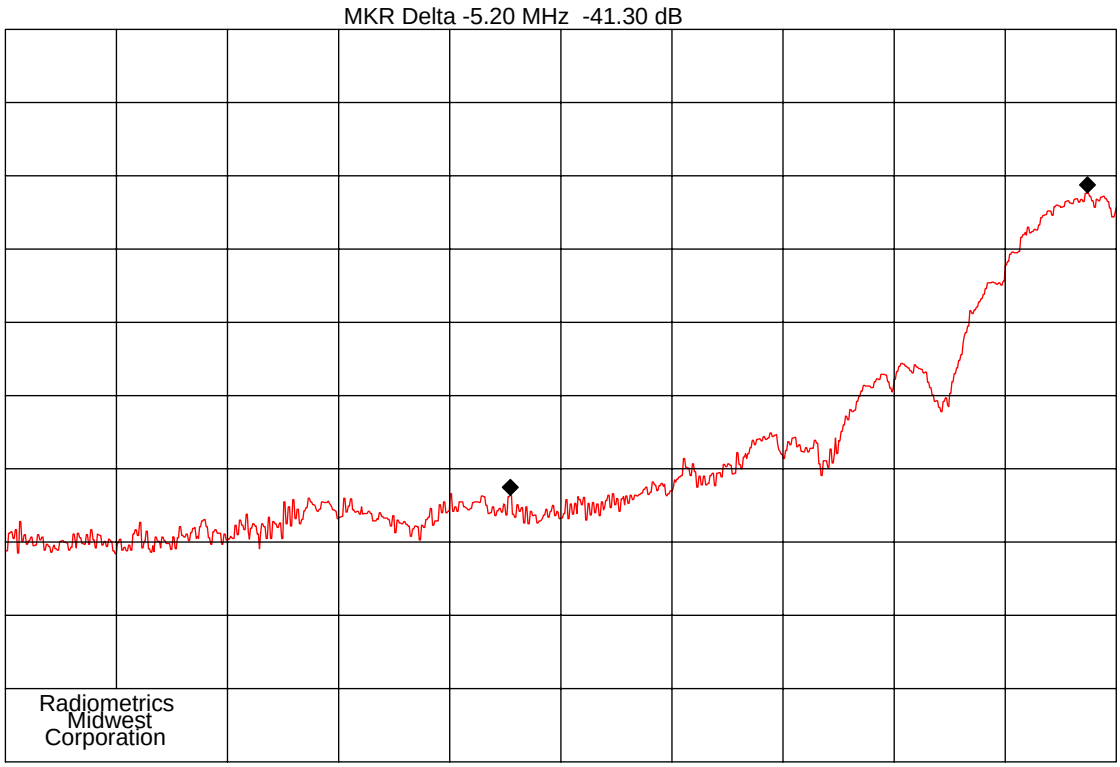
COMPANY : InDesign
CENTER 2.405 00 GHz
RES BW 100 kHz
10 dB/
NOTES : 20 dB, Occupied Bandwidth

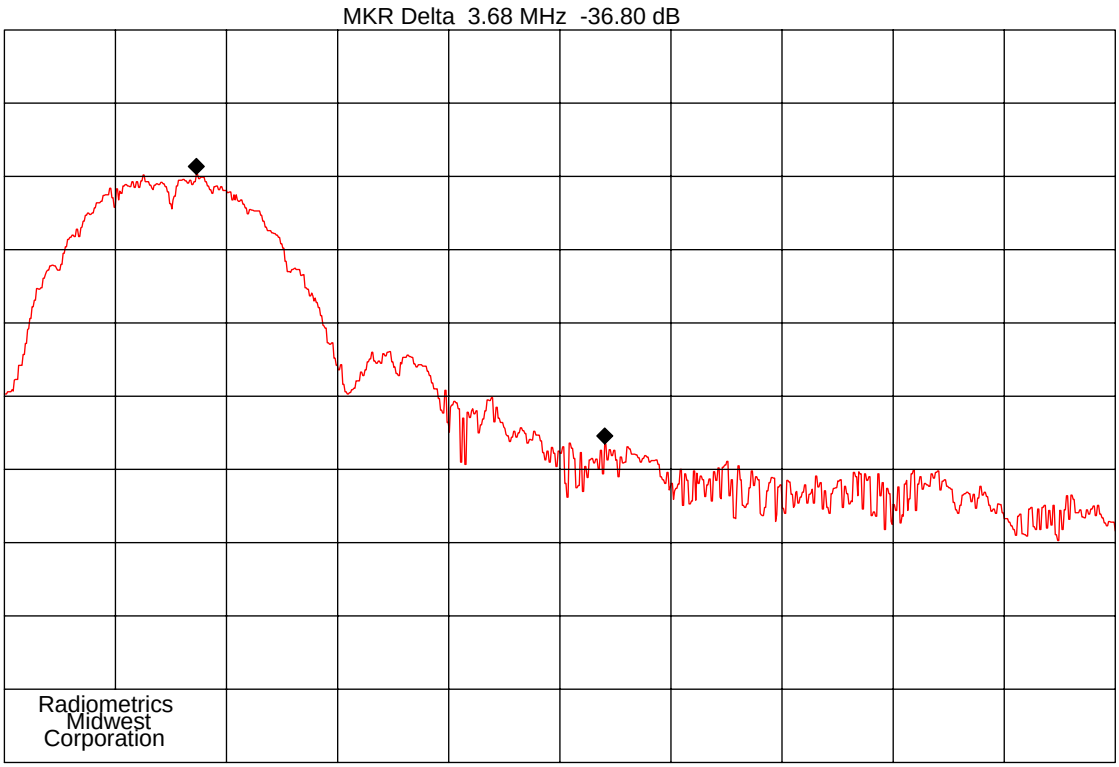
ITEM : RCS
REF 97.0 dBuV
VBW 300 kHz
TIME : 13:00

DATE : 12-30-2008
SPAN 5.00 MHz
ATTEN 10 dB
SWP 20.0 msec

10.3 Band-edge Compliance of RF Radiated Emissions

The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation at the band-edge, with the EUT set to the lowest frequency. The trace was allowed to stabilize.





The band edge measurements were in accordance to FCC publication 913591.

STEP 1 – In Band field strenght measurements were Performed using a 1 MHz RBW peak and average detector function.
STEP 2 - A spectrum analyzer span that shows the peak of the fundamental emission and the band edge emission was set. The RBW was 100 kHz. Several sweeps were performed in peak hold mode. The amplitude delta between the peak of the fundamental and the peak of the band edge emission was measured.
STEP 3 – The delta measured in step (2) was Subtracted from the field strengths measured in step (1). The resultant field strengths are then used to determine band edge compliance as required by Section 15.205.
The above delta measurement technique was used for measuring emissions that are up to two standard bandwidths away from the band edge.

10.4 Radiated Emissions

Radiated emission measurements were performed with linearly polarized broadband antennas. The results obtained with these antennas can be correlated with results obtained with a tuned dipole antenna. Below 1 GHz, when a radiated emission is detected approaching the specification limit, the measurement of the emission is repeated using a tuned dipole antenna with a Roberts Balun. A 10 dB linearity check is performed prior to start of testing in order to determine if an overload condition exists. Measurements were performed using two antenna polarizations, (vertical and horizontal). The worst case emissions were recorded.

From 30 to 1000 MHz, an Anritsu spectrum analyzer was used. For tests from 1 to 25 GHz, an HP 8566 spectrum analyzer was used. For tests from 1 to 10 GHz, a high pass filter was used to reduce the fundamental emission. A harmonic mixer was used from 18 to 25 GHz. Figure 3 herein lists the details of the test equipment used during radiated emissions tests.

Final radiated emissions measurements were performed in the open area test site at a test distance of 3 meters. The entire frequency range from 30 to 25000 MHz was slowly scanned and the emissions in the restricted frequency bands were recorded. Measurements were performed using the peak detector function. The detected emission levels were maximized by rotating the EUT, adjusting the positions of all cables, and by scanning the measurement antenna from 1 to 4 meters above the ground. The open area test site used to collect the radiated data is located on 8625 Helmar Road in Newark, Illinois. The open field test site has a metal ground screen. All other tests are performed at 12 East Devonwood Ave. Romeoville, Illinois EMI test lab.

The was device was rotated through three orthogonal axis as per 13.1.4.1 of ANSI C63.4 during the prescans and during final radiated tests.

10.4.1 Radiated Emissions Field Strength Sample Calculation

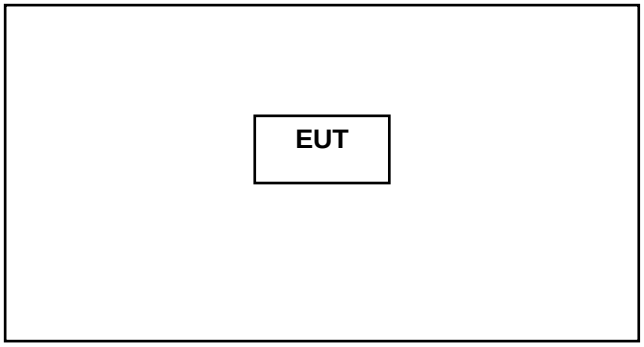
The field strength is calculated by adding the Antenna Factor and Cable Loss, and by subtracting the Amplifier Gain from the measured reading. The basic equation is as follows:

FS = RA + AF + CF - AG

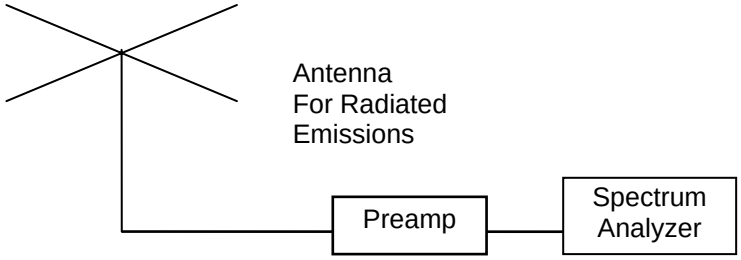
Where: FS = Field Strength
RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Attenuation Factor
AG = Amplifier Gain
HPF = High pass Filter Loss
PKA = Peak to Average Factor (This is zero for non-average measurements)

The Peak to average factor is used when average measurements are required. It is calculated by the highest duty cycle in percent over any 100mS transmission. The factor in dB is 20 * Log(Duty cycle/100).

Figure 3. Drawing of Radiated Emissions Setup



Notes:
- AC outlet with low-pass filter at the base of the turntable
- Antenna height varied from 1 to 4 meters
- Distance from antenna to tested system is 3 meters
- Not to Scale



Frequency Range	Receive Antenna	Pre-Amplifier	Spectrum Analyzer	High Pass Filter
30 to 1000 MHz	ANT-44	AMP-33	REC-03	None*
1 to 10 GHz	ANT-13	AMP-05	REC-01	HPF-03
10 to 18 GHz	ANT-13	AMP-20	REC-01	None*
18 to 25 GHz	ANT-48	AMP-29	REC-08; MXR-01	None*

* A high pass filter was not needed since the fundamental frequency was outside of the amplifiers' pass band.

10.4.2 Radiated Emissions Test Results

The following spectrum analyzer settings were used.

Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ RBW
Sweep = auto

Detector function = peak
Trace = max hold

Manufacturer	Ultra-UnderSea Sensor Systems, Inc.	Specification	FCC Part 15.249 & RSS-210
Model	242135	Test Date	12/29/2008
Serial Number	none	Test Distance	3 Meters
Abbreviations	Pol = Antenna Polarization; V = Vertical; H = Horizontal		
Notes	Corr. Factors = Cable Loss – Preamp Gain – Duty Cycle Factor + HP Filter Loss		

Emissions Below 2 GHz

Freq. MHz	Peak Meter Reading dBuV	Antenna Factor dB	Antenna Pol/ ID#	Corr. Factors dB	Field Strength dBuV/m EUT	Field Strength dBuV/m Limit	Margin Under Limit dB
60.4	34.2 P	9.9	V/44	-30.2	13.9	39.1	25.2
76.8	29.9 P	6.6	V/44	-29.9	6.5	39.1	32.6
220.8	24.4 P	11.6	V/44	-28.7	7.3	46.4	39.1
320.6	38.8 P	13.8	V/44	-28.0	24.6	46.4	21.8
335.1	33.3 P	14.3	V/44	-27.8	19.8	46.4	26.6
422.1	25.8 P	16.3	V/44	-27.3	14.8	46.4	31.6
658.0	24.2 P	19.2	V/44	-25.8	17.5	46.4	28.9
891.0	24.5 P	21.5	V/44	-24.6	21.4	46.4	25.0
1124.0	26.2 P	23.3	V/44	-23.7	25.8	49.5	23.7
1277.0	26.1 P	23.8	V/44	-23.0	26.9	49.5	22.6
59.6	37.8 P	11.5	H/44	-30.3	19.1	39.1	20.0
94.0	26.1 P	8.6	H/44	-29.8	4.9	43.5	38.6
223.2	24.9 P	11.8	H/44	-28.7	8.0	46.4	38.4
277.6	24.8 P	13.1	H/44	-28.2	9.7	46.4	36.7
323.5	24.9 P	14.2	H/44	-28.0	11.1	46.4	35.3
374.5	25.4 P	15.7	H/44	-27.5	13.7	46.4	32.7
431.3	24.8 P	16.4	H/44	-27.1	14.1	46.4	32.3
596.0	24.5 P	19.1	H/44	-26.3	17.3	46.4	29.1
890.0	25.3 P	22.3	H/44	-24.6	23.0	46.4	23.4
1076.0	24.3 P	23.4	H/44	-23.7	24.0	49.5	25.5
1209.0	25.6 P	24.2	H/44	-23.3	26.5	49.5	23.0

Emissions above 2 GHz

hrm #	Tx Freq	Ant Pol.	Analyzer Peak RDG dBuV	Analyzer Ave RDG dBuV	Corr. Fact. dB	EUT Emission Freq MHz	Field Strength from EUT Peak dBuV/m	Field Strength from EUT Ave dBuV/m	Field Strength Limit Peak dBuV/m	Field Strength Limit Ave dBuV/m	Margin Under Limit dB
1	2405	V	86.7	82.8	4	2405	90.7	86.8	114	94	7.2
1	2405	H	83.1	79.2	4	2405	87.1	83.2	114	94	10.8
be	2405	V	46.5	42.6	3.9	2400	50.4	46.5	74	54	7.5
be	2405	H	42.9	39.0	3.9	2400	46.8	42.9	74	54	11.1
2	2405	V	34.6	30.7	12.1	4810	46.7	42.8	74	54	11.2
2	2405	H	35	31.1	12.1	4810	47.1	43.2	74	54	10.8

hrm #	Tx Freq	Ant Pol.	Analyzer Peak RDG dBuV	Analyzer Ave RDG dBuV	Corr. Fact. dB	EUT Emission Freq MHz	Field Strength from EUT Peak dBuV/m	Field Strength from EUT Ave dBuV/m	Field Strength Limit Peak dBuV/m	Field Strength Limit Ave dBuV/m	Margin Under Limit dB
3	2405	V	35.2	31.3	15.8	7215	51	47.1	74	54	6.9
3	2405	H	35.4	31.5	15.8	7215	51.2	47.3	74	54	6.7
1	2440	V	88	84.1	4.1	2440	92.1	88.2	114	94	5.8
1	2440	H	82.3	78.4	4.1	2440	86.4	82.5	114	94	11.5
2	2440	V	35.1	31.2	12.4	4880	47.5	43.6	74	54	10.4
2	2440	H	35.1	31.2	12.4	4880	47.5	43.6	74	54	10.4
3	2440	V	35.4	31.5	15.9	7320	51.3	47.4	74	54	6.6
3	2440	H	35.2	31.3	15.9	7320	51.1	47.2	74	54	6.8
1	2480	V	87.6	83.7	4.3	2480	91.9	88.0	114	94	6.0
1	2480	H	80.8	76.9	4.3	2480	85.1	81.2	114	94	12.8
be	2480	V	50.7	46.8	4.4	2483.5	55.1	51.2	74	54	2.8
be	2480	H	43.9	40.0	4.4	2483.5	48.3	44.4	74	54	9.6
2	2480	V	34.4	30.5	12.4	4960	46.8	42.9	74	54	11.1
2	2480	H	34.5	30.6	12.4	4960	46.9	43.0	74	54	11.0
3	2480	V	35.5	31.6	16.5	7440	52	48.1	74	54	5.9
3	2480	H	34.8	30.9	16.5	7440	51.3	47.4	74	54	6.6

The margin is the worst case for ave or peak.

Judgment: Passed by 2.8 dB
No other emissions were detected in the restricted bands.