LS Research, LLC

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ENGINEERING TEST REPORT # 307359-FAR

Compliance Testing of:
FAR READER

Test Date(s):
March 27 and April 22, 2008

Prepared For:
Strattec Security Corporation
Attn.: Mr. George Barker
3333 West Good Hope Road
Milwaukee, WI 53209

In accordance with:
Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.209
General Operating Requirements for Low-Power License-Exempt Transmitters

This Test Report is issued under the Authority of:
Brian E. Petted, VP of Engineering

Signature: Date: May 1, 2008

Test Report Reviewed by:	**Tested by:**
Teresa A. White, Quality Manager	Kenneth L. Boston, Sr. EMC Engineer
Signature: Teresa A. White	Signature: Kenneth L Boston
Date: May 1, 2008	Date: May 1, 2008

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EXHIBIT 1. INTRODUCTION

1.1 SCOPE

References:	FCC Part 15, Subpart C, Section 15.209
Title:	Telecommunication – Code of Federal Regulations, CFR 47, Part 15
Purpose of Test:	To gain FCC Certification Authorization for Low-Power License-Exempt Transmitters.
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
Environmental Classification:	• Commercial, Industrial or Business • Residential

1.2 NORMATIVE REFERENCES

Publication	Year	Title
47 CFR, Parts 0-15 (FCC)	2005	Code of Federal Regulations - Telecommunications
ANSI C63.4	2003	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
CISPR 16-1-1	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus.
CISPR 16-2-1	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 201: Conducted disturbance measurement.

1.3 LS Research, LLC TEST FACILITY

LS Research, LLC 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".

LS Research, LLC's scope of accreditation includes all test methods listed herein, unless otherwise noted. A copy of the accreditation may be accessed on our web site: www.lsr.com. Accreditation status can be verified at A2LA's web site: www.a2la2.net.

1.4 LOCATION OF TESTING

All testing was performed at LS Research, LLC, W66 N220 Commerce Court, Cedarburg, Wisconsin, 53012 USA, utilizing the facilities listed below, unless otherwise noted.

List of Facilities Located at LS Research, LLC:

- Compact Chamber
- Semi-Anechoic Chamber
- Open Area Test Site (OATS)

1.5 TEST EQUIPMENT UTILIZED

A complete list of equipment utilized in testing is provided in Appendix A of this test report. Calibration dates are indicated in Appendix A. All test equipment is calibrated in accordance with A2LA standards.

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 CLIENT INFORMATION

Manufacturer Name:	**Strattec Security Corporation**
Address:	**3333 W. Good Hope Road** **Milwaukee, WI 53209**
Contact Person:	**George Barker 414.247.3343** **gbarker@strattec.com**

2.2 EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information has been supplied by the applicant.

Product Name:	Far Reader
Model Number:	5908934
Serial Number:	n/a

2.3 ASSOCIATED ANTENNA DESCRIPTION

The Far Reader transmit antenna is an external solenoid wound ferrite core inductor which is connected to the Far Reader by means of a 2 conductor cable. In application, the antenna is placed in the cab of the vehicle in a convenient location within 4 feet of the vehicle operator.

The 433 MHz receive antenna for the Far Reader is a length of wire, or a coaxial sleeve dipole. For coaxial sleeve dipole, antenna gain is 1.7 dBi. for the wire antenna, gain is 0 dBi.

The 125 KHz antenna for the Far Reader is an external air-core inductor. The coil is made resonant to 125 KHz through a series L-C-R circuit. There is a discrete series capacitor selected for the inductance of the coil and cable together so as to achieve a resonant condition at 125 KHz.

2.4 EUT'S TECHNICAL SPECIFICATIONS

Additional Information:

Frequency Range (in MHz)	.125 MHz
RF Power in Watts	Note 1
Conducted Output Power (in dBm)	Note 1
EIRP (in mW)	6.3 mW (+8 dBm)
Field Strength (and at what distance)	74.4 dBuV/m @ 10 m
Occupied Bandwidth (99% BW)	8.3 kHz
Type of Modulation	1000 bps NRZ, ASK
Emission Designator	2K1D
Transmitter Spurious (worst case)	35.4 dBuV/m @ 45.3 MHz, 3m
Receiver Spurious (worst case)	35.4 dBuV/m @ 45.3 MHz, 3m
Frequency Tolerance %, Hz, ppm	n/a
Microprocessor Model # (if applicable)	n/a
EUT will be operated under FCC Rule Part(s)	15.209
Antenna Information:	
a) Antenna Type	Inductive Loop
b) Detachable/Non-Detachable	Non-Detachable
c) Antenna Gain (in dBi)	Note 1
Modular Filing	☒ Yes ☐ No
Application	Fixed

Note 1: Direct measurement of the conducted power output was not possible, due to the lack of a suitable direct output port from the device, and further, antenna gain cannot be determined.

RF Technical Information:

Type of Evaluation (check one)		SAR Evaluation: Device Used in the Vicinity of the Human Head
		SAR Evaluation: Body-worn Device
	X	RF Evaluation

If RF Evaluation checked above, test engineer to complete the following:

- Evaluated against exposure limits: ☒ General Public Use ☐ Controlled Use
- Duty Cycle used in evaluation: 100 %
- Standard used for evaluation: 15.209, RSS 210 (issue 7, 2007)
- Measurement Distance: 10 m
- RF Value: <0.005 ☒ V/m ☐ A/m ☐ W/m^2
  ☐ Measured ☐ Computed ☒ Calculated

2.5 PRODUCT DESCRIPTION

The Far Reader is comprised of a 125 kHz transmitter and a 433.92 MHz receiver. This product is used as part of a wireless ignition key. The transmit frequency is 125 kHz (fixed channel), which frequency is determined by an L-C oscillator. The Far Reader also has a fixed channel 433.92 MHz receiver. This receiver is fixed tuned by virtue of an on-board crystal frequency reference.

The Far Reader is powered by nominal 12 VDC automotive supplies (13.6 VDC).

Peripheral equipment to the Far Reader are connected through multi-conductor cables. In application, a "Near Reader" commands the Far Reader to operate.

In order to test the transmitter in a representative system, a Near reader module and a Far reader module are configured along with a typical lead wire harness for the system as installed in an automobile or other vehicle. The test configuration components are attached to a stiff, perforated fiberboard backing, and includes a bracket with the necessary switches and controls, a set of control relays, and a fuse-block. It also includes the necessary loop antennas for both readers. These loop antennas were not permanently mounted on the perforated board, and were rotated through all axes in order to maximize the measured field strength,

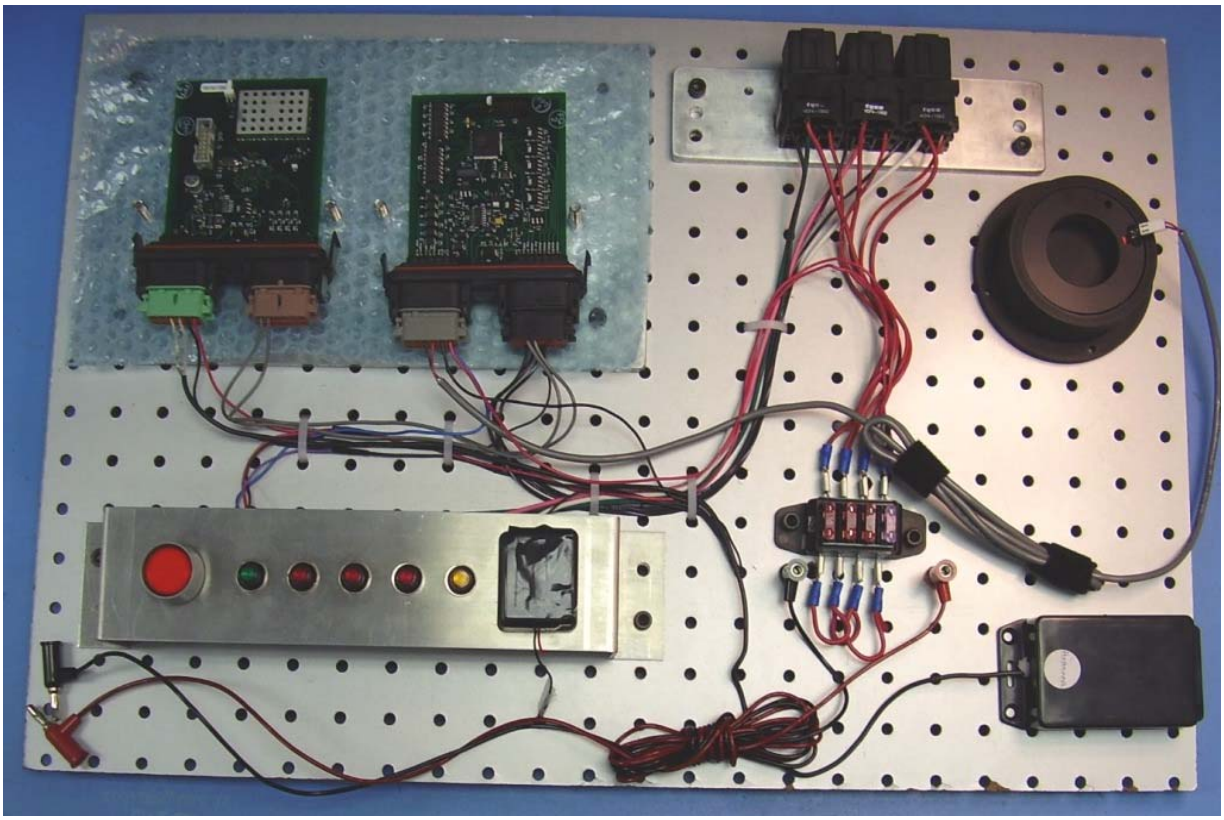


EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 CLIMATE TEST CONDITIONS

Temperature:	20-25 degrees C
Humidity:	30-60%
Pressure:	86-106 kPa

3.2 APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Paragraph	Test Requirements	Compliance (yes/no)
1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	YES
15.207	Power Line Conducted Emissions Measurements	N/A
15.209 (a)	Maximum RF Output Power	YES
15.209 (c)	Maximum RF Spurious Emissions	YES
15.109 & 15.205	Transmitter General Radiated Emissions	YES
The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices and the associated Radio Receiver has also been tested and found to comply with Part 15, Subpart B – Radio Receivers. The Receiver Test Report is available upon request.		

3.3 MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

☒ **None** ☐ **Yes (explain below)**

No additional components were required for device compliance with the 15.209 limits

3.4 DEVIATIONS & EXCLUSIONS FROM TEST SPECIFICATIONS

☒ **None** ☐ **Yes (explain below)**

EXHIBIT 4. DECLARATION OF CONFORMITY

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.209, and Industry Canada RSS-210 (Issue 7, 2007), Section 2.6 for a Low-Power License-Exempt Transmitters

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

EXHIBIT 5. RADIATED EMISSIONS TEST

5.1 Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15 and ANSI C63.4-2003. The test sample was operated within the 3 meter semi-anechoic, FCC listed chamber, and on the 10 meter Open Air Test Site (OATS). The test sample was operated with power supplied by a 12.7 VDC rechargeable battery. The EUT was positioned upon an 80 cm high wooden table/pedestal which was positioned upon the 2 meter turntable within the chamber. The measurement antenna, mounted upon a motorized mast was then placed 3 meters from the product. This allowed the EUT to be scanned in both azimuth and elevation. For low frequency measurements, the product was operated while positioned on the 10 meter OATS. The measurement antenna, an active loop antenna, was positioned 10 meters away, and oriented to give maximum signal levels. These 10 meter OATS measurements were performed for the transmitter fundamental, and harmonics up through the 10^{th} harmonic.

5.2 Test Procedure

The fundamental and spurious (harmonic) emissions of the transmitter were tested for compliance to the general limits given in Title 47 CFR, FCC Part 15.209. For the calculations used to determine the limits applicable for the test sample, refer to Section 5.5 of this test report. These limits are expressed in decibels (dB) above 1 microvolt per meter (uV/m). The samples were tested from the lowest frequency generated by the transmitter (without going below 9 kHz) to the 10^{th} harmonic of the fundamental frequency generated by the device. The appropriate limits were also observed when the fundamental or spurious signals were located within any of the restricted bands as described in Part 15.205a. The EUT was setup in the 3 Meter FCC listed Semi-Anechoic chamber, upon the 2 meter turntable in the chamber, with an antenna mast placed 3 meters from the test object perimeter. A biconical antenna was used to measure emissions from 30 to 200 MHz, a log periodic antenna was used to measure emissions from 200 to 1000 MHz. The test object was placed in continuous transmit, and the spurious signals were maximized by rotating the turntable 360 degrees, and by raising and lowering the antenna between 1 and 4 meters, being tested using both horizontal and vertical antenna polarities. Brief scans below 30 MHz were also performed in the chamber, using an active loop antenna as the sensing antenna. Information from this 3 meter test was used to identify frequencies for further investigation during the emissions tests on the 10 meter OATS. For measurement of the transmitter fundamental, harmonics and low frequency spurious signals, a magnetic loop antenna was used, which was placed at a separation distance of 10 meters upon an FCC listed OATS. The loop and product orientation were then varied to obtain the maximum signal levels and then readings were taken.

The unit was scanned for emissions in both transmit and standby modes, over the range of 125 kHz to 1000 MHz to establish compliance with Part 15.109 for the transmitter. Also, the scans were performed to evaluate the digital controller section of the product, which is subject to verification as a Class B digital device. Any significant spurious signals, other than the noise floor of the system, are tabulated in the data section in this test report.

5.3 Test Equipment Utilized

A list of the test equipment and antennas utilized for the Radiated Emissions test can be found in Appendix A. This list includes calibration information and equipment descriptions. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. All calibrations of the antennas used were performed at an N.I.S.T. traceable site. In addition, the Connecting Cables were measured for losses using a calibrated Signal Generator and a HP 8546A EMI Receiver. The resulting correction factors and the cable loss factors from these calibrations were entered into the HP 8546A EMI Receiver database. As a result, the data taken from the HP 8546A EMI Receiver accounts for the antenna correction factor as well as cable loss or other corrections, and can therefore be entered into the database as a corrected meter reading. The HP 8546A EMI Receiver was operated with resolution bandwidths as prescribed in ANSI C63.4 (2003).

Test Equipment List

Test Equipment	Manufacturer	Model No.	Serial No.
EMI Receiver	HP	8546A	3617A00320
EMI Receiver Pre-Select.	HP	85460A	3448A00296
Spectrum Analyzer	Agilent	E4446A	US45300564
Log Periodic Antenna	EMCO	93146	9701-4855
Horn Antenna	EMCO	3115	6907
Bicon Antenna	EMCO	93110B	9702-2918
Active Loop Antenna	EMCO	6502	9205-2753
Pre-Amp	Adv. Microwave	WLA612	1145A04094
Horn Antenna – Std. Gain	EMCO	3160-09	9809-1120

5.4 Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.209 for a Low-Power License-Exempt transmitter [Canada RSS-210 (Issue 7, 2007), section 2.6]. The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

5.5 CALCULATION OF RADIATED EMISSIONS LIMITS

The maximum peak output power of an intentional radiator in the 9-490 kHz band, as specified in Title 47 CFR 15.209, is calculated in a formula as described below. The harmonic and spurious RF emissions, with appropriate receiver bandwidths, as specified in 15.209 (c), shall be below the measured power of the desired signal, and must also meet the requirements described in 15.205(c) where applicable.

The following table depicts the general radiated emission limits. These limits are obtained from Title 47 CFR, Part 15.209, for radiated emissions measurements. These limits were applied to the fundamental emission of the intentional radiator as well as all other significant spurious signals.

Frequency (MHz)	Limit μV/m	Limit (dBμV/m)	Measurement Distance (m)
0.009-0.490	2400/F (kHz)	Note 1	300
0.490-1.705	24000/F (kHz)		30
1.705-30.0	30		30
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
960-24,000	500	54.0	3

Note 1: Sample calculation for the Fundamental Emission of the transmitter:

Given the transmitter operates at a fundamental frequency of 125 kHz, the emission limit may be calculated:

2400/F = 2400/125 = 19.2 μV/m if measured at 300 meters separation.

Expressed in decibels: $20 \log_{10} (19.2) = 25.67$ dBμV/m at 300 m separation.

At 3 and 10 meter separation, the limit may be extrapolated by the addition of 40 dB/decade per 47CFR 15.31(f)(2)

Limit for the fundamental emission = 25.67 dBμV/m + 80 dB = 105.67 dB/μV/m at 3 meters

Limit for the fundamental emission = 25.67 dBμV/m + 59.08 dB = 84.75 dB/μV/m at 10 meters

LIMITS FOR READINGS TAKEN AT 10 METERS

Frequency (MHz)	FCC Limit (uV/m)	FCC Limit (dBuV/m)	Scaling Factor	Adjusted Limit (dBuV/m)
0.125	19.20 @ 300 m	25.67	59.08	84.75
0.250	9.60 @ 300 m	19.64	59.08	78.72
0.375	6.40 @ 300 m	16.12	59.08	75.20
0.500	48.0 @ 30 m	33.62	19.08	52.70
0.625	38.40 @ 30 m	31.69	19.08	50.77
0.750	32.0 @ 30 m	30.10	19.08	49.18
0.875	27.43 @ 30 m	28.76	19.08	47.84
1.000	24.0 @ 30 m	27.60	19.08	46.68
1.125	21.33 @ 30 m	26.58	19.08	45.66
1.250	19.20 @ 30 m	25.67	19.08	44.75
1.705 – 30.0	30.0 @ 30 m	29.54	19.08	48.62

5.6 RADIATED EMISSIONS DATA CHART

3 Meter Measurements of Electromagnetic Radiated Emissions
Test Standard: 47CFR, Part 15.209
Frequency Range Inspected: 9 kHz to 1000 MHz

Manufacturer:	Strattec Security Corporation						
Date(s) of Test:	March 27 and April 22, 2008						
Test Engineer(s):	Ken Boston						
Voltage:	12.7 VDC						
Operation Mode:	Continuous Transmit						
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %						
EUT Power:		Single Phase ___VAC		3 Phase ___VAC			
		Battery	X	Other: 12.7 VDC			
EUT Placement:		80cm non-conductive table		10cm Spacers			
EUT Test Location:	X	3 Meter Semi-Anechoic FCC Listed Chamber	X	10m OATS			
Measurements:		Pre-Compliance		Preliminary	X	Final	
Detectors Used:		Peak	X	Quasi-Peak	X	Average	

The following table depicts the level of significant spurious radiated RF emissions measured at 3 meters:

Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	Emission Limit (dBμV/m)	Margin (dB)
39.3	V	1.0	270	33.6	40.0	6.4
45.4	V	1.0	270	34.4	40.0	5.6
44.9	V	1.0	270	35.3	40.0	4.7
45.3	V	1.0	270	35.4	40.0	4.6
45.8	V	1.0	270	34.8	40.0	5.2
99.7	H	2.2	0	25.0	40.0	15.0

The following table depicts the level of significant radiated RF fundamental and harmonic emissions at 10 meters:

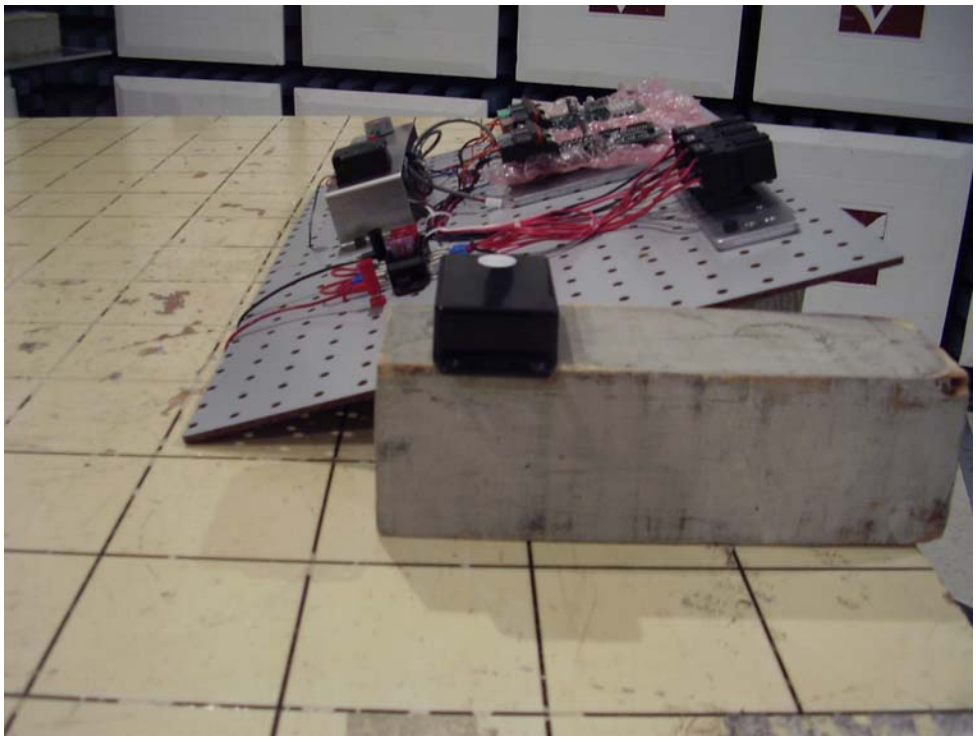
Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.209 Limit (dBμV/m)	Margin (dB)
0.128	V/V	1.0	0	74.4	84.7	10.3
0.257	V/V	1.0	0	42.0	78.7	36.7
0.389	V/V	1.0	0	44.1	75.2	31.1

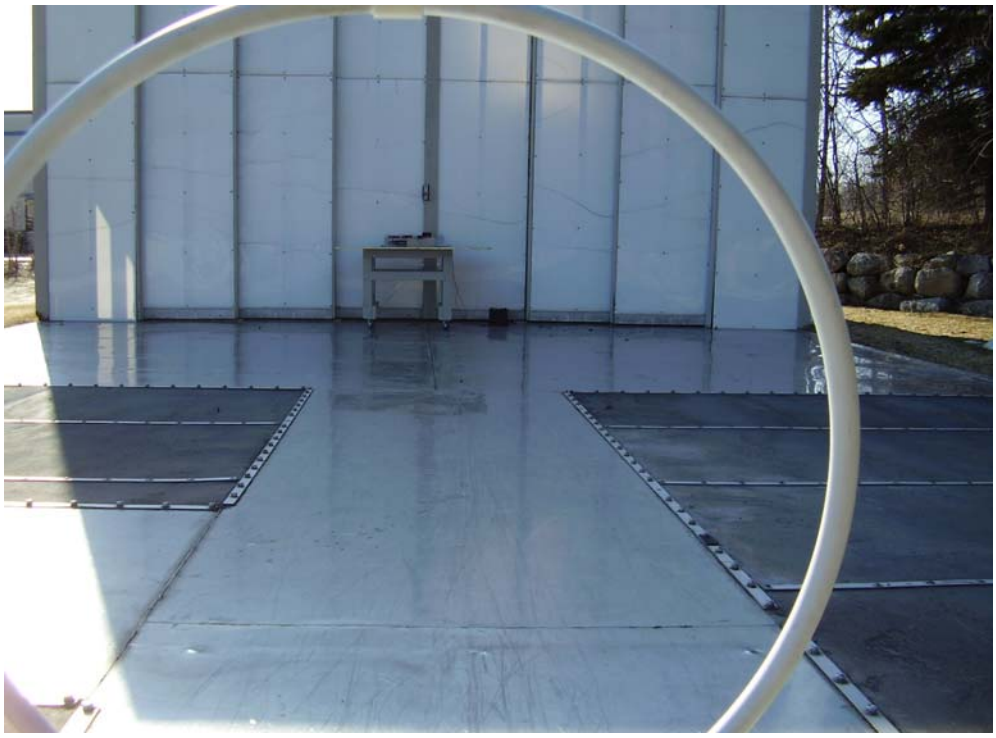
Notes:

1) An Average Detector function was used to measure the readings between 110 kHz – 490 kHz, and a Quasi-Peak Detector was used in measurements between 30 MHz and 1 GHz.
2) Transmitter harmonics above 500 kHz were seen to be at or below the system noise floor at 10 meters.
3) Highest peak emission of the fundamental was 76.5 dBuV/m, and the highest peak harmonic level, at 257 kHz was 48.0 dBuV/m, at 389 kHz it was 47.9 dBuV/m. All these levels were compliant.
4) The nominal frequency of the Far reader is 125 kHz, although the actual frequency of the transmitter may vary slightly because it is an LC based oscillator. This implies that the limit for field strength compliance varies slightly with frequency, although the margin of compliance is large enough to allow for this drift to occur and remain compliant.

5.7 Test Setup Photo(s) – Radiated Emissions Test

EUT on Test Table, and on 10 meter site

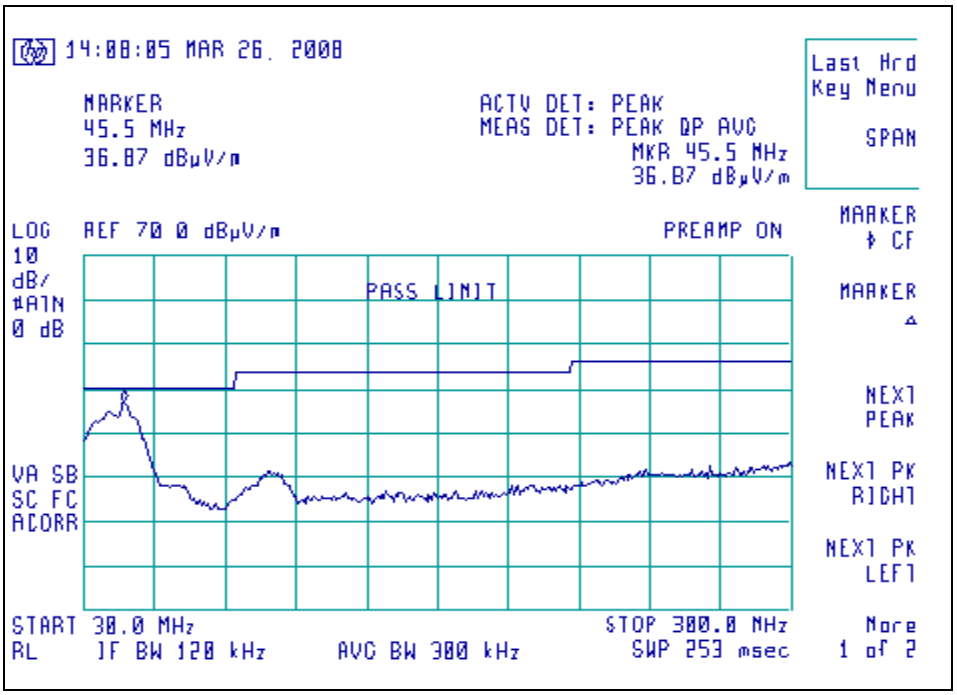




5.8 Screen Captures - Radiated Emissions Testing

These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak or Average detector function is utilized when measuring frequencies below 1 GHz.

Antenna Vertically Polarized, 30-300 MHz, at 3m



Antenna Vertically Polarized, 300-1000 MHz, at 3m

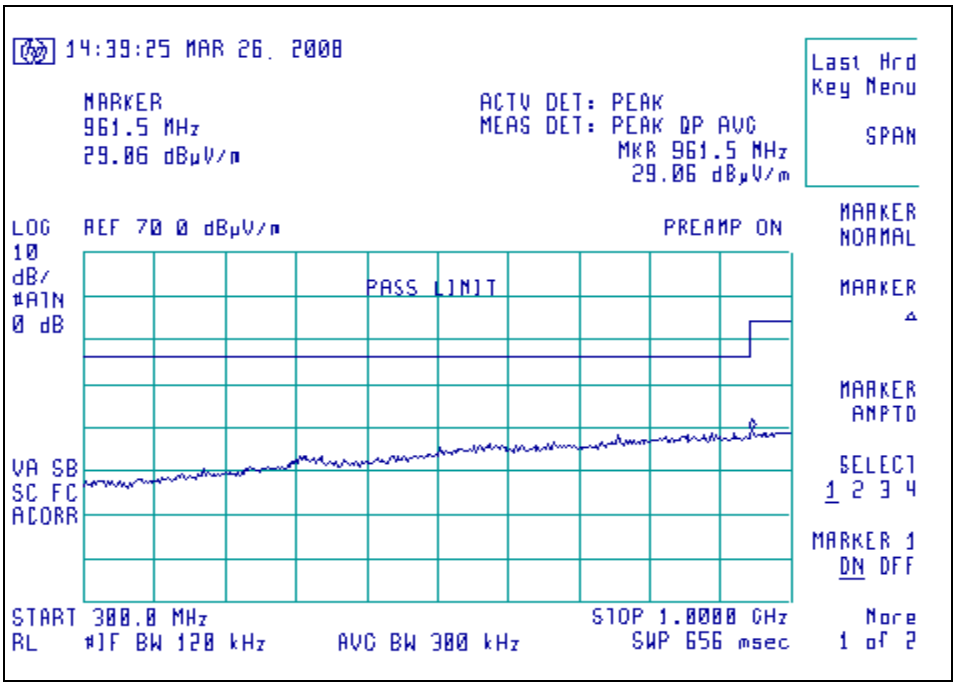


EXHIBIT 6. OCCUPIED BANDWIDTH

6.1 Limits

There are no stated limits for the occupied bandwidth for devices operating under 47CFR Part 15.209. The data presented here is for completeness only.

6.2 Method of Measurements

ANSI C63.4 and FCC standard procedures were adhered to in these measurements.

The transmitter output was placed in continuous transmit mode, while programmed to create a standard transmit modulated packet train. The bandwidth of the fundamental frequency was measured with the Spectrum Analyzer using RBW= 1 kHz and VBW= 1 kHz.

Test Data

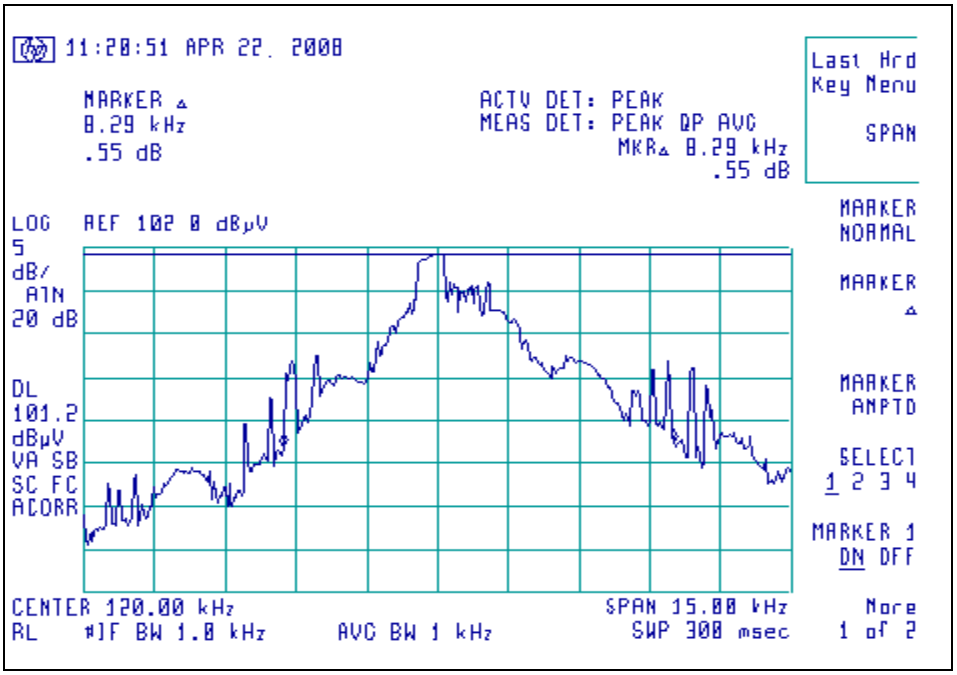
Center Frequency (MHz)	Measured -6 dBc Occ. BW (kHz)	Measured -20 dBc Occ.Bw (kHz)
0.120	1.6	8.3

6.3 Test Equipment List

Test Equipment	Manufacturer	Model No.	Serial No.
Spectrum Analyzer	Agilent	E4407B	US39160256
Spectrum Analyzer	Agilent	E4446A	US45300564

6.4 Screen Captures - OCCUPIED BANDWIDTH

-20 dBc Occupied Bandwidth



-6 dBc Occupied Bandwidth

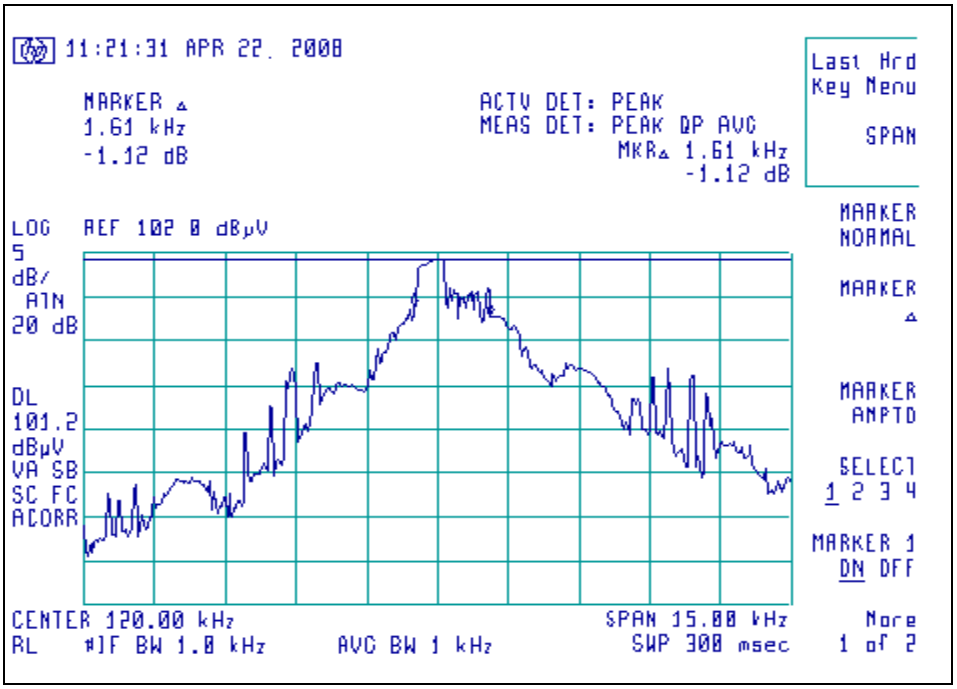


EXHIBIT 7. FREQUENCY & POWER STABILITY OVER VOLTAGE & VARIATIONS

The stability of the device was examined as a function of the input voltage available to the EUT. A Spectrum Analyzer was used to measure the frequency at the appropriate frequency markers. For this test, the EUT was placed in CW modulated continuous transmit mode. Power was supplied by an external bench-type variable power supply, and the frequency of operation was monitored using the spectrum analyzer, with the antenna placed inside the chamber. The power supply was varied to 85% of the lower end of the nominal operating voltage range, and at 115% of the upper end of the nominal operating voltage range (12.0 – 13.6 VDC nominal).

	DC Voltage Source (vdc)		
	10.2 VDC	12.7 VDC	15.7 VDC
	131.49 (kHz)	131.50 (kHz)	131.58 (kHz)

APPENDIX A

Test Equipment List

Asset #	Manufacturer	Model #	Serial #	Description	Date	Due
AA960006	EMCO	6502	9205-2753	Active Loop Antenna	9/18/07	9/18/08
AA960008	EMCO	3816/2NM	9701-1057	Line Impedance Stabilization Network	12/6/07	12/6/08
AA960031	HP	119474A	3107A01708	Transient Limiter	Note 1	Note 1
AA960077	EMCO	93110B	9702-2918	Biconical Antenna	9/19/07	9/19/08
AA960078	EMCO	93146	9701-4855	Log-Periodic Antenna	9/19/07	9/19/08
AA960081	EMCO	3115	6907	Double Ridge Horn Antenna	12/04/07	12/04/08
CC00221C	Agilent	E4407B	US39160256	Spectrum Analyzer	1/11/07	1/11/08
EE960004	EMCO	2090	9607-1164	Device Controller	N/A	N/A
EE960013	HP	8546A	3617A00320	Receiver RF Section	9/20/07	9/20/08
EE960014	HP	85460A	3448A00296	Receiver Pre-Selector	9/20/07	9/20/08
EE960073	Agilent	E4446A	US45300564	Spectrum Analyzer	8/17/07	8/17/08
N/A	LSC	Cable	0011	3 Meter ½" Armored Cable	Note 1	Note 1
N/A	LSC	Cable	0050	10 Meter RG 214 Cable	Note 1	Note 1
N/A	Pasternack	Attenuator	N/A	10 dB Attenuator	Note 1	Note 1

Note 1 - Equipment calibrated within a traceable system.

Uncertainty Statement

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k=2.

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.24 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.8 dB
Radiated Emissions	10-Meter OATS, Biconical Antenna	4.18 dB
Radiated Emissions	10-Meter OATS, Log Periodic Antenna	3.92 dB
Conducted Emissions	Shielded Room/EMCO LISN	1.60 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	1.128 Volts/Meter
Conducted Immunity	3 Volts level	1.0 V