LS RESEARCH, LLC
WIRELESS PRODUCT DEVELOPMENT
ACCREDITED
Testing Cert. 1255.01
W66 N220 Commerce Court ● Cedarburg, WI 53012 ● USA
Phone: 262.375.4400 ● Fax: 262.375.4248
www.lsr.com

LSR Job #: C-588

TCB Rev. 3

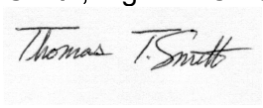
Compliance Testing of:
SEMS II

Test Date(s):
January 19th to 21st 2009 (2.4 GHz radio)
April 3, 2009.

Prepared For:
SCOTT Health & Safety
4320 Goldmine Rd.
Monroe NC 28110

In accordance with:
Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247
Digital Modulation Transmitters (DTS) Operating in the
Frequency Band 2400 MHz – 2483.5 MHz

This Test Report is issued under the Authority of:
Thomas T. Smith, Mgr. EMC Test Services

Signature:  Date: April 9, 2009

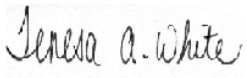
Test Report Reviewed by:	**Tested by:**
Teresa A. White, Quality Manager	Khairul Aidi Zainal, Senior EMC Engineer
Signature: 	Signature: 
Date: April 9, 2009	Date: April 9, 2009

TABLE OF CONTENTS *(page 1 of 2)*

TABLE OF CONTENTS *(page 2 of 2)*

EXHIBIT 1. INTRODUCTION

1.1 SCOPE

References:	FCC Part 15, Subpart C, Section 15.247 and 15.209 FCC Part 2, Section 2.1043 paragraph (b)1.
Title:	FCC : 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)	2007-10	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	2006-03 A1: 2006-09 A2: 2007-07	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus.
CISPR 16-2-1	2003 A1: 2004-04 A2: 2007-07	Specification for radio disturbance and immunity measuring apparatus and methods. Part 201: Conducted disturbance measurement.
FCC Public Notice DA 00-1407	2000	Part 15 Unlicensed Modular Transmitter Approval
FCC ET Docket No. 99-231	2002	Amendment to FCC Part 15 of the Commission's Rules Regarding Spread Spectrum Devices.
FCC Procedures	2007	Measurement of Digital Transmission Systems operating under Section 15.247.

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. 2.4GHz radio PERFORMANCE ASSESSMENT

2.1 CLIENT INFORMATION

Manufacturer Name:	**SCOTT Health & Safety**
Address:	**4320 Goldmine Rd. Monroe NC 28110**

2.2 EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information has been supplied by the applicant.

Product Name:	SEMS II
Model Number:	200729-01; 200729-02 and 200729-03
Serial Number:	Engineering Unit

2.3 ASSOCIATED ANTENNA DESCRIPTION

The antenna used by the EMBER radio is a Nearson Custom made PCB dipole that is potted. The Potted gain of the antenna is -3.5dBi average and +1.8 dBi peak. (Refer to specification sheet in Appendix C). The antenna has a U.FL connector that is used to connect to the SEMS II board.

2.4 EUT'S TECHNICAL SPECIFICATIONS

Additional Information:

Frequency Range (in MHz)	SEMS II = 2405 MHz
RF Power in Watts	SEMS II = 0.079 Watts
Conducted Output Power (in dBm)	SEMS II = 19.0 dBm
Field Strength (and at what distance)	SEMS II =113.4 dBuV/m at 3m (2405 MHz)
Occupied Bandwidth	6 dB BW = 1.20 MHz 20 dB BW = 2.27 MHz
Type of Modulation	DSSS (Spread Spectrum)
Emission Designator	2M27G1D
EIRP (in mW)	66 mW
Transmitter Spurious (worst case)	61.2 dBuV/m at 1 meter (9620 MHz)
Frequency Tolerance %, Hz, ppm	>100 ppm
Microprocessor Model # (if applicable)	EM260 (Ember)
Antenna Information	
Detachable/non-detachable	Non – detachable with U.FL Connector
Type	Internal PCB dipole (potted)
Gain (in dBi)	Potted average gain = -3.9dBi Potted maximum gain = +1.8dBi
EUT will be operated under	FCC : CFR 47 part 15.247
Modular Filing	☐ Yes ☒ No
Portable or Mobile?	Portable

RF Technical Information:

Type of Evaluation (check one)		SAR Evaluation: Device Used in the Vicinity of the Human Head
		SAR Evaluation: Body-worn Device
	√	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: FCC 47 CFR part 1 and RSS 102
- Measurement Distance: 20cm
- RF Value: 0.23918 ☐ V/m ☐ A/m ☒ W/m^2
  ☐ Measured ☐ Computed ☒ Calculated

NOTE: Please refer to Appendix D for SAR test exclusion justification.

2.5 PRODUCT DESCRIPTION

The 2.4GHz transceiver portion of the SEMS II console is a transceiver that operates only on one channel (2405 MHz) and is an IEEE 802.15.4 radio for ZigBee networking.

It communicates with a PCMCIA card that is connected to a PC as the base station. The system provides an Ad-Hoc network between the console units and the base station providing the users with a greater range than competitive point to point systems currently on the market. The transmitter is capable of transmitting an SCBA (Self Contained Breathing Apparatus) identification name, manual and auto PASS alarms, air pressure, and a withdraw message. The console is capable of receiving an evacuate message from the base station and an RF range message, both incorporating visual and audible indicators for all alarms and messages.

EXHIBIT 3. 2.4 GHz radio OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 CLIMATE TEST CONDITIONS

Temperature:	70°
Humidity:	36%
Pressure:	735mmHg

3.2 APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC and IC Paragraph	Test Requirements	Compliance (yes/no)
FCC : 15.247(a)(2)	6 dB Bandwidth of a Digital Modulation System	Yes
FCC : 15.247(b) & 1.1310	Maximum Output Power	Yes
FCC : 15.247(i), 1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
FCC :15.247(c)	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC : 15.247(d)	Transmitted Power Spectral Density of a Digital Modulation System	Yes
FCC : 15.247(c), 15.209 & 15.205	Transmitter 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)**

3.4 DEVIATIONS & EXCLUSIONS FROM TEST SPECIFICATIONS

☒ **None** ☐ **Yes (explain below)**

EXHIBIT 4. 2.4GHz Radio DECLARATION OF CONFORMITY

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.247 for a Digital Spread Spectrum (DTS) Transmitter.

If some emissions are seen to be within 3 dB of their respective limits:
As these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

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. 2.4GHz Radio 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 EUT was placed on an 80cm high non-conductive pedestal, centered on a flush mounted 2-meter diameter turntable inside a 3 meter Semi-Anechoic, FCC listed Chamber. The EUT was operated in continuous transmit mode for final testing, using power as provided by batteries. The unit has the capability to operate on one channel.

The applicable limits apply at a 3 meter distance. Measurements above 4 GHz were performed at a 1.0 meter separation distance. The calculations to determine these limits are detailed in the following pages. Please refer to Appendix A for a complete list of test equipment. The test sample was operated on one channel since the 2.4GHz ZigBee radio operates only on this channel

5.2 Test Procedure

Radiated RF measurements were performed on the EUT in a 3 meter Semi-Anechoic, FCC listed Chamber. The frequency range from 30 MHz to 25000 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the EUT. A Biconical Antenna was used to measure emissions from 30 MHz to 300 MHz, and a Log Periodic Antenna was used to measure emissions from 300 MHz to 1000 MHz. A Double-Ridged Waveguide Horn Antenna was used from 1 GHz to 18 GHz. The maximum radiated RF emissions were found by raising and lowering the antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities. From 18 GHz to 25 GHz, the EUT was measured at a 0.6 meter separation, using a standard gain Horn Antenna and pre-amplifier.

The battery voltage was checked frequently, and the batteries were replaced as necessary.

The EUT was rotated along three orthogonal axes during the investigations to find the highest emission levels.

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 a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of 300 kHz), and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 1 MHz) From 5 GHz to 18 GHz, an HP E4446A Spectrum Analyzer and an EMCO Horn Antenna were used. From 18 GHz to 25 GHz, the HP E4446A Spectrum Analyzer with a standard gain horn, and preamp were used.

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
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 15.247 for a DTS transmitter. 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 2400-2483.5 MHz band, as specified in Title 47 CFR 15.247 (b)(3) is 1 Watt. The harmonic and spurious RF emissions, as measured in any 100 kHz bandwidth, as specified in 15.247 (d), shall be at least 20 dB below the measured power of the desired signal, and must also meet the requirements described in 15.205(c) for FCC.

The following table depicts the general radiated emission limits above 30 MHz. These limits are obtained from Title 47 CFR, Part 15.209, for radiated emissions measurements. These limits were applied to any signals found in the 15.205 restricted bands.

Frequency (MHz)	3 m Limit μV/m	3 m Limit (dBμV/m)	1 m Limit (dBμV/m)
30-88	100	40.0	-
88-216	150	43.5	-
216-960	200	46.0	-
960-24,000	500	54.0	63.5

Sample conversion from field strength μV/m to dBμV/m:
$dB\mu V/m = 20 \log_{10} (100)$
= 40 dBμV/m (from 30-88 MHz)

Field strength limit for radiated fundamental at 3 meters.

Limit = 1 watt = 30 dBm = $P_T + G_T$
$P_T + G_T = E + 20\log d - 104.77$ (This equation derived from power density equation)
E = 30dBm +95.23 = 125.2 dBuV/m

For measurements made at 1.0 meter, a 9.5 dB correction has been invoked.

960 MHz to 10,000 MHz
500μV/m or 54.0 dB/μV/m at 3 meters
54.0 + 9.5 = 63.5 dB/μV/m at 1 meter

For measurements made at 0.6 meter, a 14.0 dB correction has been invoked.

960 MHz to 10,000 MHz
500μV/m or 54.0 dB/μV/m at 3 meters
54.0 + 14.0 = 68.0 dB/μV/m at 0.4 meters

5.6 RADIATED EMISSIONS DATA CHART

3 Meter Measurements of Electromagnetic Radiated Emissions
Test Standard: 47CFR, Part 15.205 and 15.247(DTS)
Frequency Range Inspected: 30 MHz to 25000MHz

Manufacturer:	TYCO/SCOTT Health & Safety						
Date(s) of Test:	January 19th to 21st 2009						
Test Engineer(s):	Aidi Zainal						
Voltage:	5.0 VDC						
Operation Mode:	continuous transmit, modulated.						
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %						
EUT Power:		Single Phase ___VAC		3 Phase ___VAC			
	√	Battery		Other:			
EUT Placement:	√	80cm non-conductive table		10cm Spacers			
EUT Test Location:	√	3 Meter Semi-Anechoic FCC Listed Chamber		3/10m OATS			
Measurements:		Pre-Compliance		Preliminary	√	Final	
Detectors Used:	√	Peak	√	Quasi-Peak	√	Average	

The following table depicts the level of significant spurious radiated RF emissions (other than harmonics) found:

Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (0° - 360°)	Measured Peak (dBμV/m)	Measured EFI (dBμV/m)	15.205 Limit (dBμV/m)	Margin (dB)
2284.0	H/S	1.85	352	53.6	42.7	54.0	11.3
2380.0	V/S	1.47	348	57.2	49.1	54.0	4.9
2384.0	V/S	1.17	348	54.1	43.0	54.0	11.0
2524.0	V/S	1.63	345	54.8	45.8	93.4	47.6

RADIATED EMISSIONS DATA CHART *(continued)*

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen:

Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (0° - 360°)	Measured Peak (dBμV/m)	Measured Average (dBμV/m)	15.247 Average Limit (dBμV/m)	Margin (dB)
2405.0	V/S	1.80	329	118.4	113.4	125.2 Note 4	11.8
4810.0	V/H	1.00	338	66.5	51.1	63.5	12.4
7215.0	H/V	1.00	0	62.1	48.7	102.9	54.2
9620.0	H/H	1.00	0	78.1	61.2	102.9	41.7
12025.0	V/H	1.27	336	60.5	44.9	63.5	18.6
14430.0	V/H	1.11	304	64.6	50.7	102.9	52.2
16835.0	H/S	1.11	85	62.9	49.0	102.9	53.9
19240.0	H/H	1.00	340	70.4	54.5	68.0	13.5
21645.0	H/H	1.06	0	61.2	47.6	107.4	59.8
24050.0	H/H	1.02	348	62.4	48.7	107.4	58.7

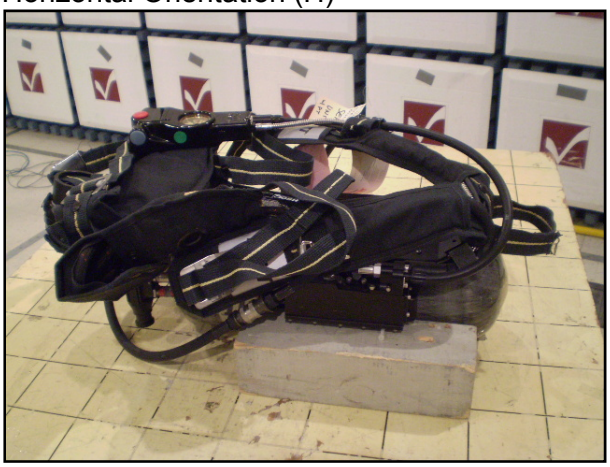
Notes:

1) A Quasi-Peak Detector was used in measurements below 1 GHz, and a Peak with video bandwidth of 10 Hz was used in measurements above 1 GHz. The peak detector was used to ensure the peak emissions did not exceed 20 dB above the limits.
2) Measurements above 4 GHz were made at 1 meters of separation from the EUT, and at 0.6 m separation for frequencies between 18 – 25 GHz.
3) For measurements of the fundamental power, because of spectral bandwidth, the receiver was set to RBW=VBW=3 MHz.
4) Please refer to Exhibit 5.5 for calculation of this limit

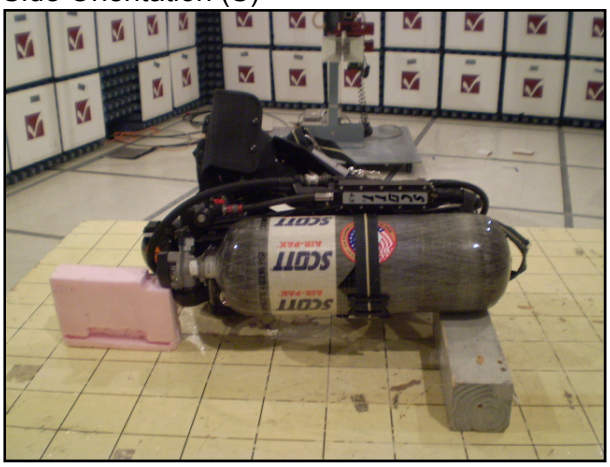
5.7 Test Setup Photo(s) – Radiated Emissions Test

Vertical Orientation (V)

Horizontal Orientation (H)



Side Orientation (S)

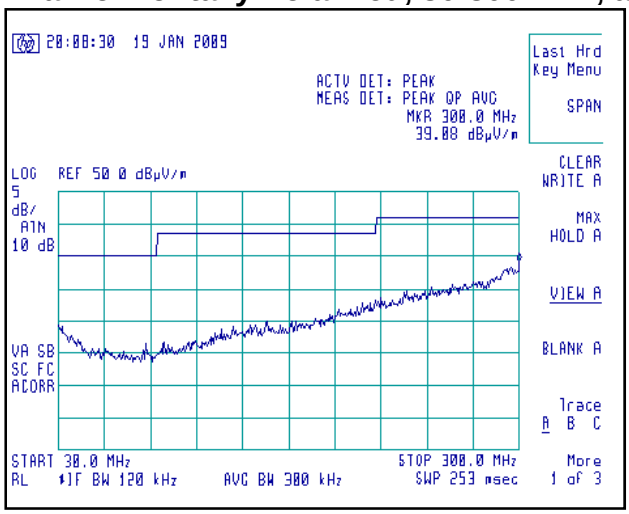


5.8 Screen Captures - Radiated Emissions Testing

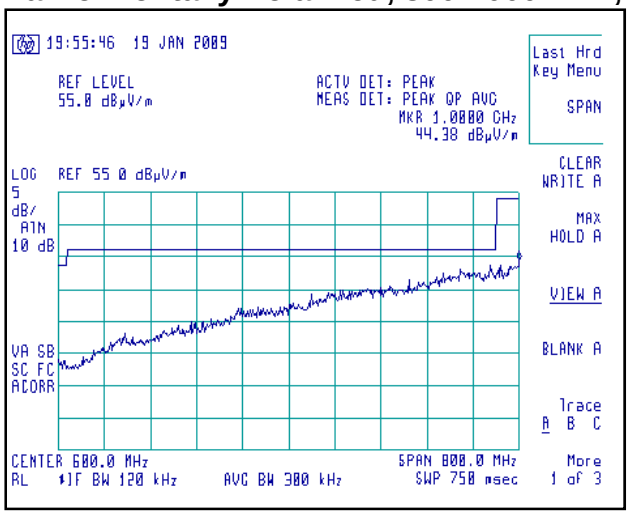
These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

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

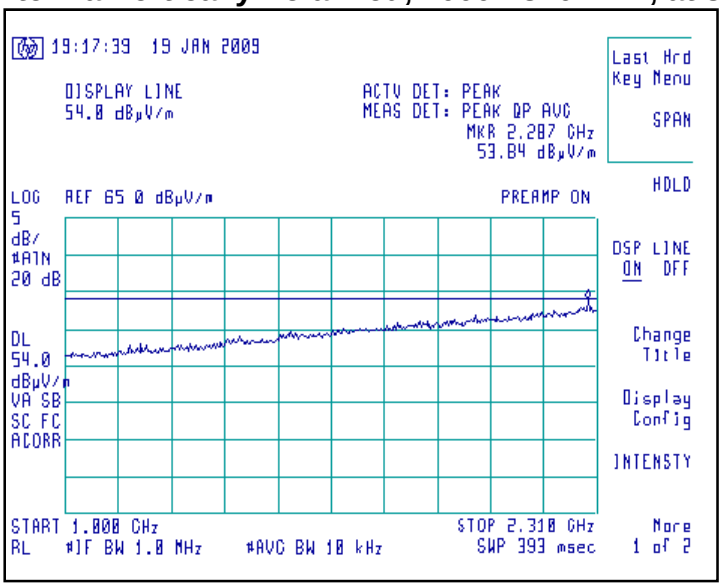


Antenna Horizontally Polarized, 300-1000 MHz, at 3m

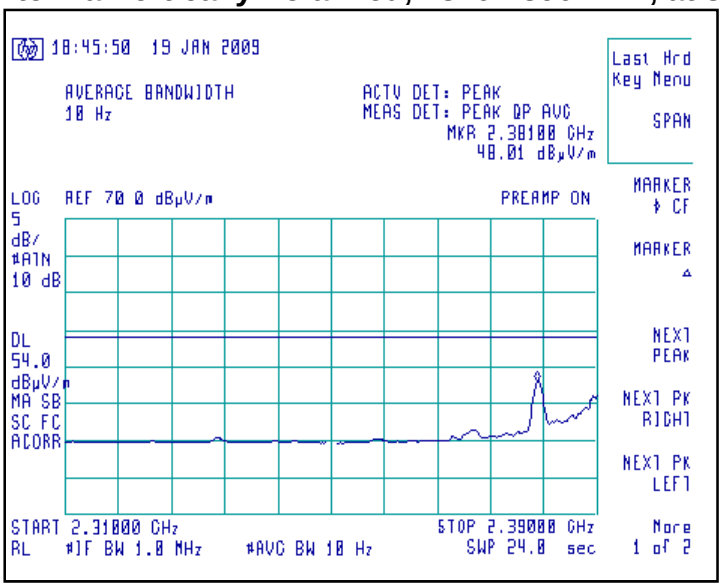


Screen Captures - Radiated Emissions Testing *(continued)*

Antenna Vertically Polarized, 1000-2310 MHz, at 3m

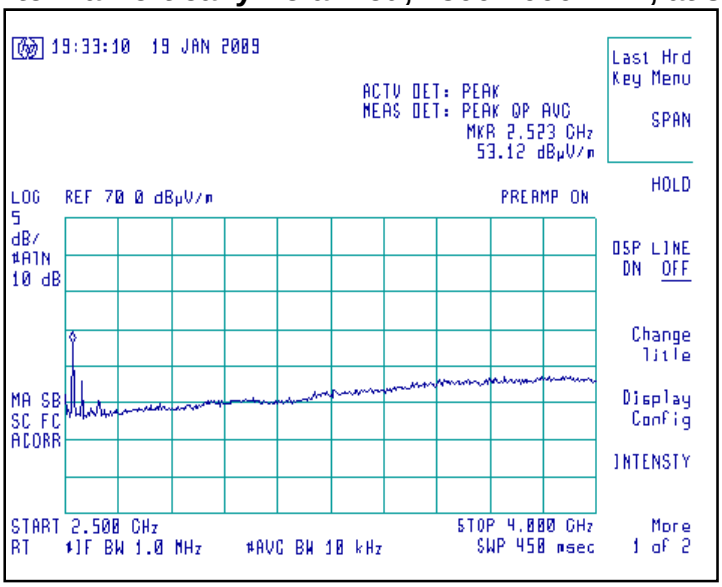


Antenna Vertically Polarized, 2310-2390 MHz, at 3m

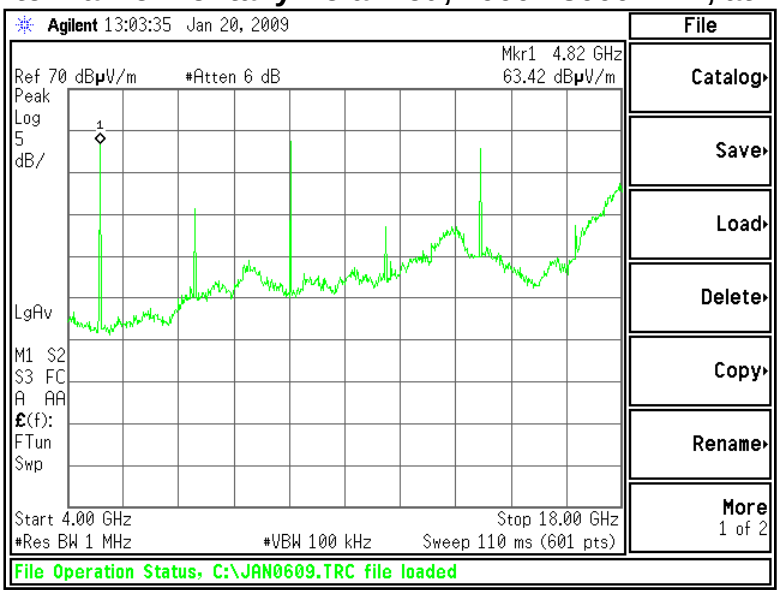


Screen Captures - Radiated Emissions Testing *(continued)*

Antenna Vertically Polarized, 2500-4000 MHz, at 3m



Antenna Horizontally Polarized, 4000-18000 MHz, at 1m



Screen Captures - Radiated Emissions Testing *(continued)*

Antenna Horizontally Polarized, 18000-25000 MHz, at 60cm

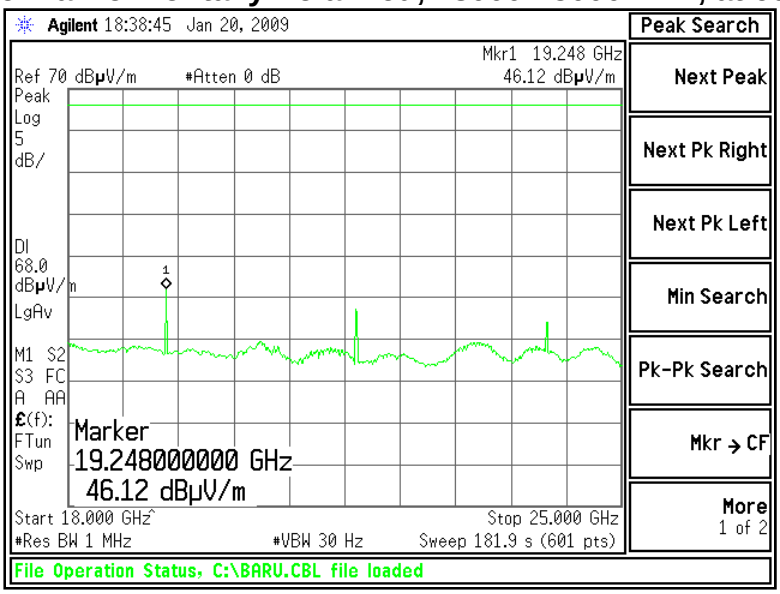


EXHIBIT 6. 2.4GHz Radio CONDUCTED EMISSIONS TEST, AC POWER LINE: 15.207

This test was not performed since the EUT is battery powered.

EXHIBIT 7. 2.4GHz Radio OCCUPIED BANDWIDTH:

7.1 Limits

For a Digital Modulation System, the 6 dB bandwidth shall be at least 500 kHz.

7.2 Method of Measurements

Refer to ANSI C63.4 (2003) and FCC Procedures (2007) for Digital Transmission Systems operating under 15.247.

The transmitter output was connected to the Spectrum Analyzer. The bandwidth of the fundamental frequency was measured with the Spectrum Analyzer using 100 kHz RBW and VBW=300 kHz.

The bandwidth requirement found in FCC Part 15.247(a)(2) requires a minimum -6dBc occupied bandwidth of 500 kHz. For this portion of the tests, a direct measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to the HP E4446A spectrum analyzer. A Hewlett Packard model E4446A spectrum analyzer was used with the resolution bandwidth set to 100 kHz for this portion of the tests. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used in peak-hold mode while measurements were made, as presented in the chart below.

From this data, the closest measurement when compared to the specified limit, is 1200 kHz, which is above the minimum of 500 kHz.

7.3 Test Data

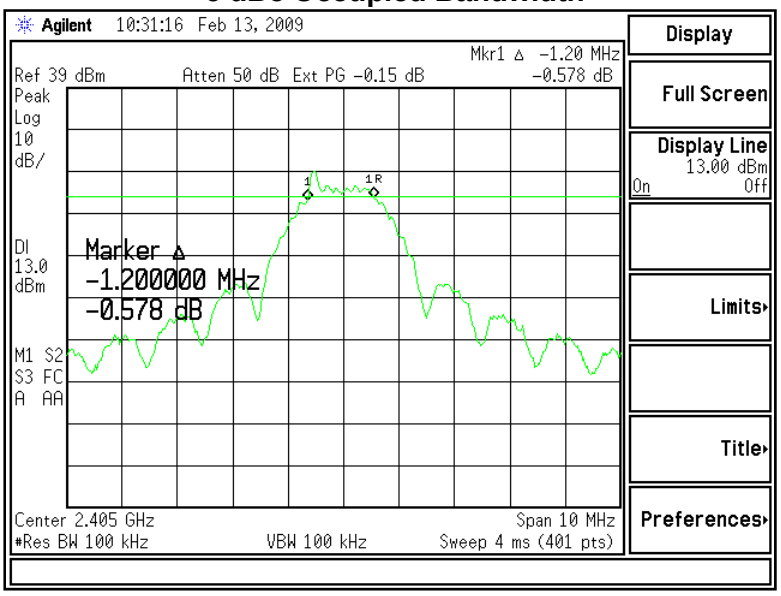
Center Frequency (MHz)	Measured -6 dBc Occ. BW (kHz)	Minimum -6 dBc Limit (kHz)	Measured -20 dBc Occ.Bw (kHz)
2405	1200	500	2270

7.4 Test Equipment List

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

7.5 Screen Captures - OCCUPIED BANDWIDTH

-6 dBc Occupied Bandwidth



-20 dBc Occupied Bandwidth

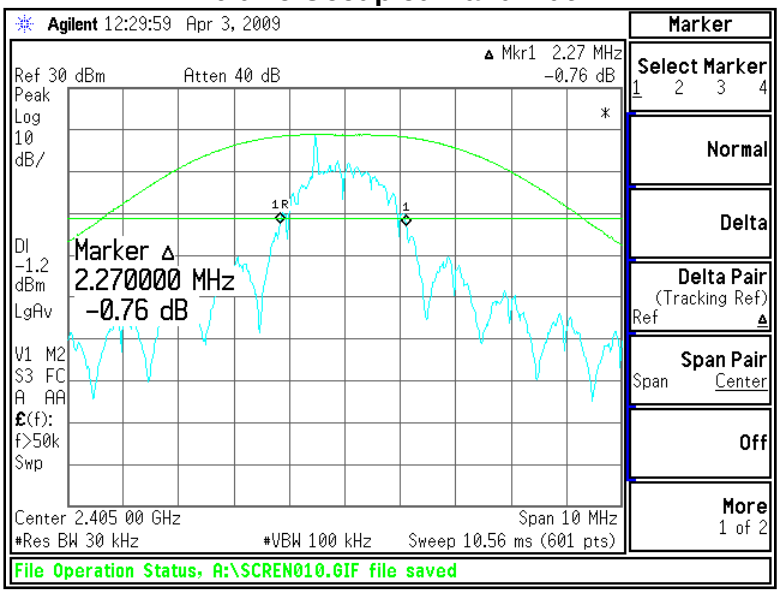
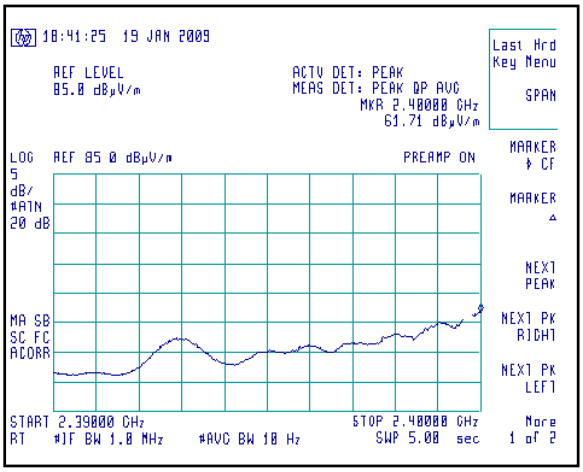


EXHIBIT 8. 2.4GHz Radio BAND-EDGE MEASUREMENTS

8.1 Method of Measurements

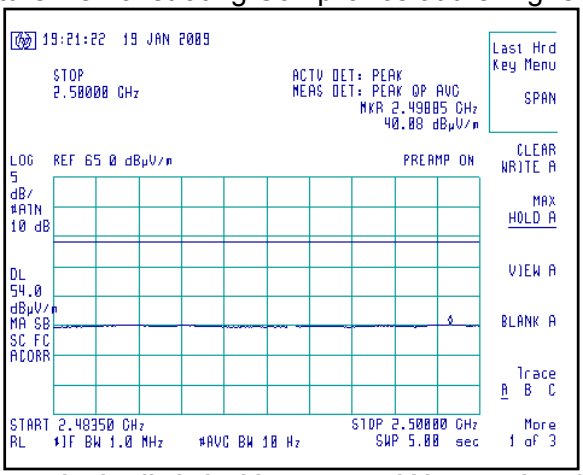
FCC 15.209(b) and 15.247(d) require a measurement of spurious emission levels to be at least 20 dB lower than the fundamental emission level, in particular at the Band-Edges where the intentional radiator operates. The following screen captures demonstrate compliance of the intentional radiator at the 2400-2483.5 MHz Band-Edges. The EUT was operated in continuous transmit mode with continuous modulation, with internally generated data as the modulating source. The EUT was operated at the lowest channel for the investigation of the lower Band-Edge, and at the highest channel for the investigation of the higher Band-Edge.

Screen Capture Demonstrating Compliance at the Lower Band-Edge



The Lower Band-Edge limit, in this case, would be -20 dBc with respect to the fundamental level (93.4 dBuV/m).

Screen Capture Demonstrating Compliance at the Higher Band-Edge



The Upper Band-Edge limit, in this case, would be + 54 dBµV/m at 3m.

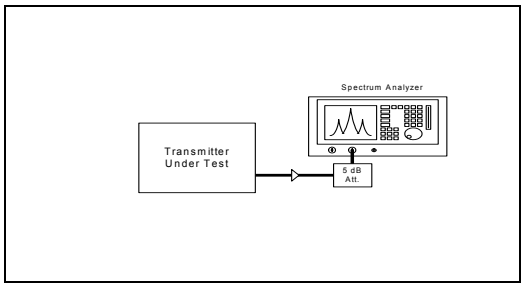
EXHIBIT 9. 2.4GHz Radio POWER OUTPUT (CONDUCTED):

9.1 Method of Measurements

The conducted RF output power of the EUT was measured at the antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings, there by allowing direct measurements without the need for any further corrections. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with resolution and video bandwidths set to 3MHz, and a span of 10 MHz, with measurements from a peak detector presented in the chart below.

9.2 Test Data

CENTER FREQ (MHz)	LIMIT (dBm)	MEASURED POWER (dBm)	MARGIN (dB)
2405	+30 dBm	19.0	11.0



Measured RF Power Output (in Watts): 0.079
Declared RF Power Output (in Watts): 0.100

9.3 Test Equipment List

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

9.4 Screen Captures – Power Output (Conducted)

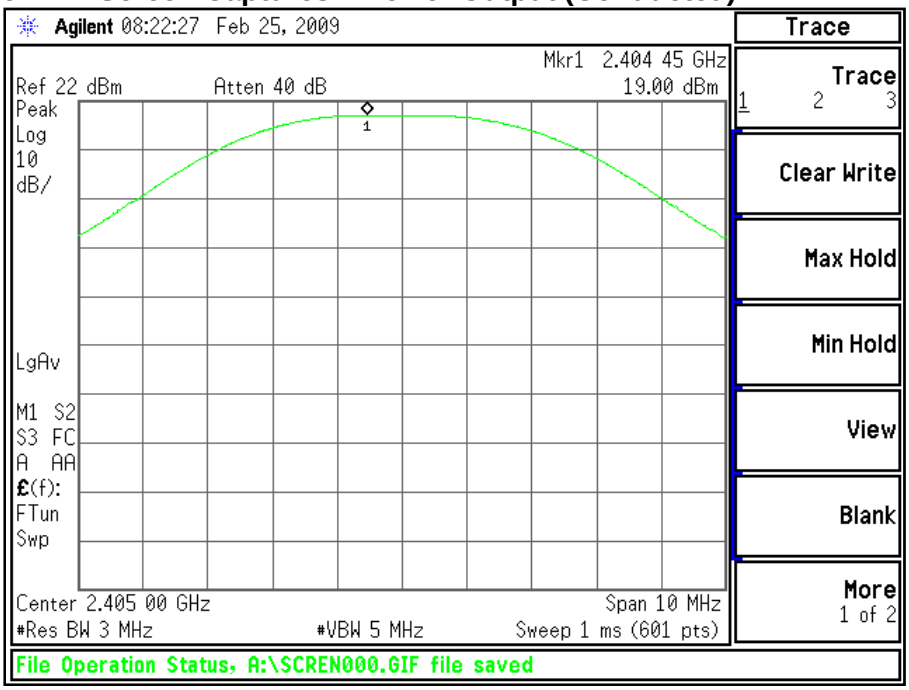


EXHIBIT 10. 2.4GHz Radio POWER SPECTRAL DENSITY:

10.1 Limits

For digitally modulate systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

In accordance with FCC Part 15.247(e), the peak power spectral density should not exceed +8 dBm in any 3 kHz band. This measurement was performed along with the conducted power output readings performed as described in previous sections. The peak output frequency for each representative frequency was scanned, with a narrow bandwidth, and reduced sweep, and a power density measurement was performed using the utility built into the HP Analyzer. The resultant density was then corrected to a 3 kHz bandwidth. The highest density was found to be no greater than 4.3dBm, which is under the allowable limit by 3.7 dB.

10.2 Test Equipment List

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

10.3 Test Data

Center Frequency (MHz)	Measured Channel Power (dBm/Hz)	3 kHz Correction (dB)	Corrected Power Measurement (dBm/3kHz)	Limit (dBm)	Margin (dB)
2405	-30.5	34.8	4.3	+8.0	3.7

10.4 Screen Captures – Power Spectral Density

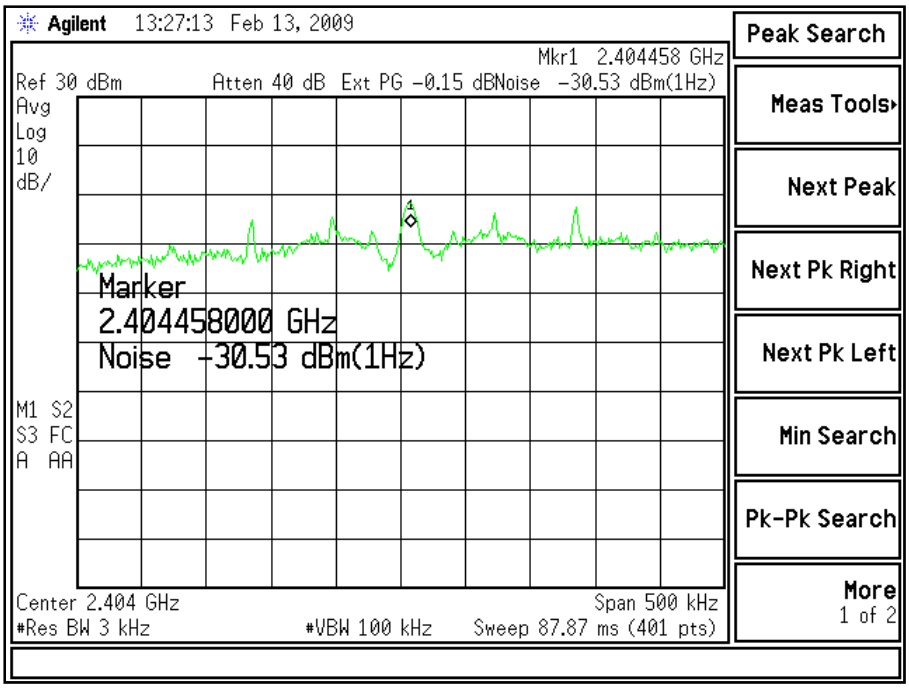


EXHIBIT 11. 2.4GHz Radio SPURIOUS RADIATED EMISSIONS:

11.1 Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at lease 20 db below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

In addition, radiated emissions, which fall in the restricted band, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(e)

Remarks:

- Applies to harmonics/spurious emissions that fall in the restricted bands listed in Section 15.205. The maximum permitted average field strength is listed in Section 15.209.
- The emission limits as specified above are based on measurement instrument employing an average detector. The provisions in Section 15.35 for limiting peak emissions apply.

FCC 47 CFR 15.205(a) – Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090 – 0.110	162.0125 – 167.17	2310 – 2390	9.3 – 9.5
0.49 – 0.51	167.72 – 173.2	2483.5 – 2500	10.6 – 12.7
2.1735 – 2.1905	240 – 285	2655 – 2900	13.25 – 13.4
8.362 – 8.366	322 – 335.4	3260 – 3267	14.47 – 14.5
13.36 – 13.41	399.9 – 410	3332 – 3339	14.35 – 16.2
25.5 – 25.67	608 – 614	3345.8 – 3358	17.7 – 21.4
37.5 – 38.25	960 – 1240	3600 – 4400	22.01 – 23.12
73 – 75.4	1300 – 1427	4500 – 5250	23.6 – 24.0
108 – 121.94	1435 – 1626.5	5350 – 5460	31.2 – 31.8
123 – 138	1660 – 1710	7250 – 7750	36.43 – 36.5
149.9 – 150.05	1718.8 – 1722.2	8025 – 8500	Above 38.6
156.7 – 156.9	2200 – 2300	9000 – 9200	

FCC 47 CFR 15.209(a) Field Strength Limits within Restricted Frequency Bands

Frequency (MHz)	Field Strength Limits (microvolts/m)	Distance (Meters)
0.009 – 0.490	2,400 / F (kHz)	300
0.490 – 1.705	24,000 / F (kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

Calculation of Radiated Emission Measurements

Frequency (MHz)	3 m Limit (μV/m)	3 m Limit (dBμV/m)	1 m Limit (dBμV/m)
30-88	100	40.0	-
88-216	150	43.5	-
216-960	200	46.0	-
960-25,000	500	54.0	63.5

FCC Part 15.247(d) requires a measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. For this test, the spurious and harmonic RF emissions from the EUT were measured at the EUT antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings, there by allowing direct readings of the measurements made without the need for any further corrections. An Agilent model E4446A spectrum analyzer was used with the resolution bandwidth set to 100 kHz for this portion of the tests. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with measurements from a peak detector presented in the chart below. Screen captures were acquired and any noticeable spurious and harmonic signals were identified and measured.

11.2 Test Equipment List

Test Equipment	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Agilent	E4446A	US45300564	To 44 GHz

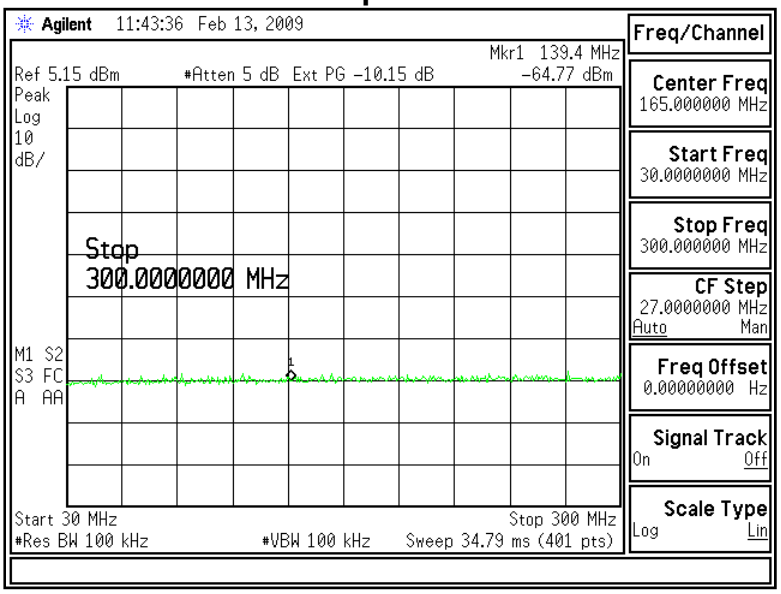
11.3 Test Data

	Power (dBm)
Fundamental	+18.8
2nd Harmonic	-52.7
3rd Harmonic	-67.9
4th Harmonic	-61.2
5th Harmonic	-70.0
6th Harmonic	-74.6
7th Harmonic	-66.7
8th Harmonic	Note (1)
9th Harmonic	Note (1)
10th Harmonic	Note (1)

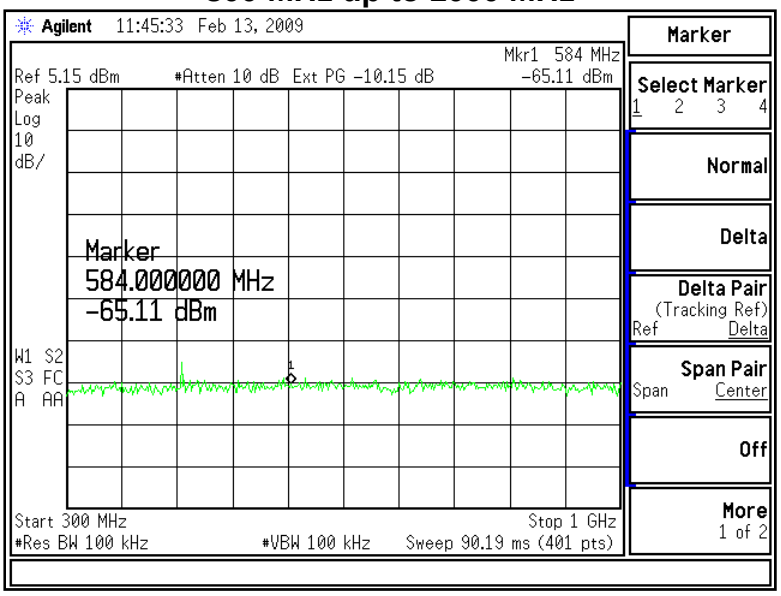
Notes:
(1) Measurement at system noise floor.

11.4 Screen Captures – Spurious Radiated Emissions

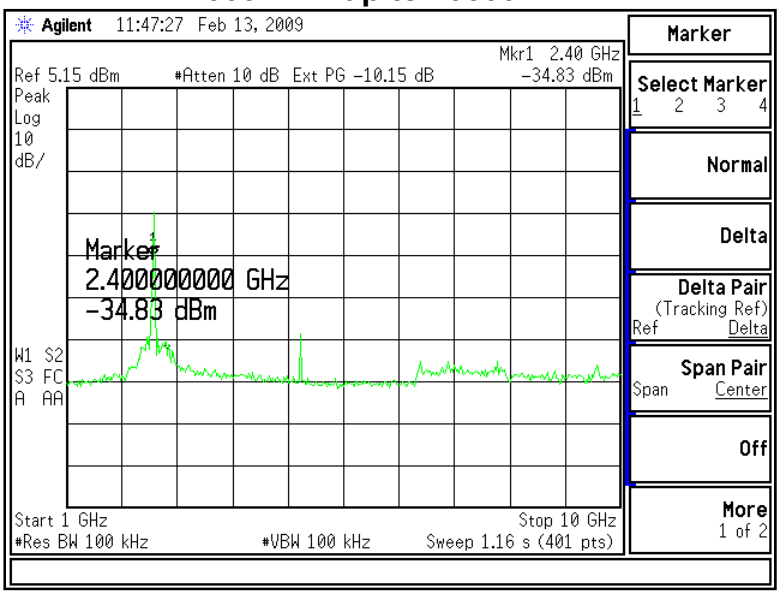
30 MHz up to 300 MHz



300 MHz up to 1000 MHz



1000 MHz up to 10000 MHz



10000 MHz up to 25000 MHz

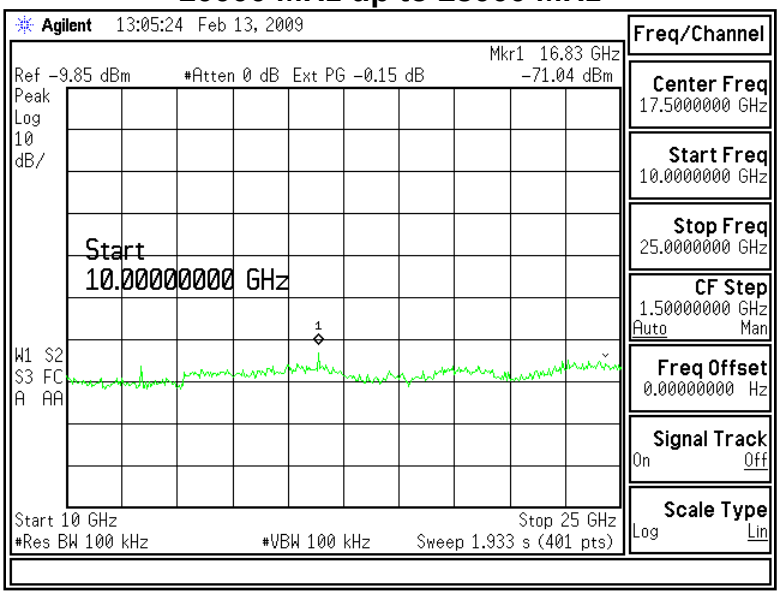


EXHIBIT 12. 2.4GHz Radio FREQUENCY & POWER STABILITY OVER VOLTAGE

A spectrum analyzer was used to measure the frequency at the appropriate frequency markers. For this test, the EUT was placed in continuous transmit mode. Power to the EUT was supplied by an external bench-type variable power supply. The frequency of operation was monitored using the spectrum analyzer while the voltage was varied.

	DC Voltage Source		
	4.25VDC	5.00VDC	5.75VDC
Channel 0	2405.0(MHz)	2405.0(MHz)	2405.0(MHz)

The RF Power Output of the EUT was also monitored in a separate test, also using a Spectrum Analyzer with RBW=VBW=3 MHz setting while the voltage was varied.

	DC Voltage Source		
	4.25VDC	4.25VDC	4.25VDC
Channel 0	19.0(dBm)	19.0(dBm)	19.0(dBm)

The power was then cycled On/Off to observe system response. No unusual response was observed, the emission characterizes were well behaved, and the system returned to the same state of operation as before the power cycle.

No anomalies were noted in the measured transmit power.

EXHIBIT 13. MPE CALCULATIONS

The following MPE calculations are based on an internal PCB dipole antenna with a measured ERP of 113.4 dBuV/m (at 3 meters) and conducted RF power of +19.0 dBm. The source based time averaged conducted RF power as presented to the antenna is 16.31 mW or 12.12 dBm (worst case). The maximum gain of this antenna, based on the data sheet is +1.8 dBi.

Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density
P = power input to the antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal:	12.12	(dBm)
Maximum peak output power at antenna input terminal:	16.293	(mW)
Antenna gain(typical):	1.8	(dBi)
Maximum antenna gain:	1.514	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	2405	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	1	(mW/cm^2)
Power density at prediction frequency:	0.004906	(mW/cm^2)
Maximum allowable antenna gain:	24.9	(dBi)
Margin of Compliance at 20 cm =	23.1	dB

APPENDIX A

Test Equipment List

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 19-Jan-2009 Type Test : Radiated Emissions Job # : C-588

Prepared By: Customer : Tyco Fire and Security Quote #: 309116

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	aa 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	12/23/2008	12/23/2009	Active Calibration
2	aa 960078	Log Periodic Antenna	EMCO	93146	9701-4855	10/20/2008	10/20/2009	Active Calibration
3	aa 960077	Bicon Antenna	EMCO	93110B	9702-2918	11/24/2008	11/24/2009	Active Calibration
4	ee 960013	EMI Receiver	HP	8546A System	3617A00320;3448A	9/23/2008	9/23/2009	Active Calibration
5	ee 960014	EMI Receiver-filter section	HP	85460A	3448A00296	9/23/2008	9/23/2009	Active Calibration
6	aa 960081	Double Ridge Horn Antenna	EMCO	3115	6907	9/26/2008	9/26/2009	Active Calibration
7	ee 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	9/26/2008	9/26/2009	Active Calibration
8	aa 960144	Phaseflex	Gore	EkD01D010720	5800373	6/10/2008	6/10/2009	Active Calibration
9	aa 960081	Double Ridge Horn Antenna	EMCO	3115	6907	9/26/2008	9/26/2009	Active Calibration

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 19-Jan-2009 Type Test : Band-Edge Job # : C-588

Prepared By: Customer : Tyco Fire and Security Quote #: 309116

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	ee 960014	EMI Receiver-filter section	HP	85460A	3448A00296	9/23/2008	9/23/2009	Active Calibration
2	ee 960013	EMI Receiver	HP	8546A System	3617A00320;3448A	9/23/2008	9/23/2009	Active Calibration
3	aa 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	12/23/2008	12/23/2009	Active Calibration

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 12-Feb-2009 Type Test : Occupied Bandwidth (6dB & 20dB) Job # : C-588

Prepared By: Customer : Tyco Fire and Security Quote #: 309116

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	ee 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	9/26/2008	9/26/2009	Active Calibration
2	aa 960144	Phaseflex	Gore	EkD01D010720	5800373	6/10/2008	6/10/2009	Active Calibration

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 12-Feb-2009 Type Test : Conducted Power Output Job # : C-588

Prepared By: Customer : Tyco Fire and Security Quote #: 309116

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	ee 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	9/26/2008	9/26/2009	Active Calibration
2	aa 960144	Phaseflex	Gore	EkD01D010720	5800373	6/10/2008	6/10/2009	Active Calibration

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 12-Feb-2009 Type Test : Power Spectral Density Job # : C-588

Prepared By: Customer : Tyco Fire and Security Quote #: 309116

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	ee 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	9/26/2008	9/26/2009	Active Calibration
2	aa 960144	Phaseflex	Gore	EkD01D010720	5800373	6/10/2008	6/10/2009	Active Calibration

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 12-Feb-2009 Type Test : Spurious Emissions Job # : C-588

Prepared By: Customer : Tyco Fire and Security Quote #: 309116

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	ee 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	9/26/2008	9/26/2009	Active Calibration
2	aa 960144	Phaseflex	Gore	EkD01D010720	5800373	6/10/2008	6/10/2009	Active Calibration

APPENDIX B
TEST STANDARDS – CURRENT PUBLICATION DATES RADIO

EN 55011	2007-05			RSS 119	2007-06		
EN 55014-1	2006			RSS 123	1999-11		
EN 55014-2	1997			RSS 125	2000-03		
EN 55022	2006			RSS 131	2003-07		
EN 60601-1-2	2007			RSS 136	2002-10		
EN 61000-3-2	2006-05			RSS 137	1999-09		
EN 61000-3-3	1994	1995		RSS 210	2007-06		
EN 61000-4-2	2001	1998	2001	RSS 213	2005-12		
EN 61000-4-3	2006-07	2008-05		RSS 243	2005-11		
EN 61000-4-4	2004			RSS 310	2007-06		
EN 61000-4-5	2006-12						
EN 61000-4-6	2007-08						
EN 61000-4-8	1993	1994-01					
EN 61000-4-11	2004-10						
EN 61000-6-1	2007-02						
EN 61000-6-2	2005-12						
EN 61000-6-3	2007-02						
EN 61000-6-4	2007-02						
FCC 47 CFR, Parts 0-15, 18, 90, 95	2007						
FCC Public Notice DA 00-1407	2000						
FCC ET Docket # 99-231	2002						
FCC Procedures	2007						
ICES 001	2006-06						
ICES 002	2007-02						
ICES 003	2004-02						
IEC 60601-1-2 Note 1	2007-03						
IEC 61000-3-2	2005	2008-03	2009-02				
IEC 61000-3-3	2008-06						
IEC 61000-4-2	2001-04	1998	2000				
IEC 61000-4-3	2006-02	incl in 2006					
IEC 61000-4-4	2004-07						

Note 1: Test not on LSR Scope of Accreditation.

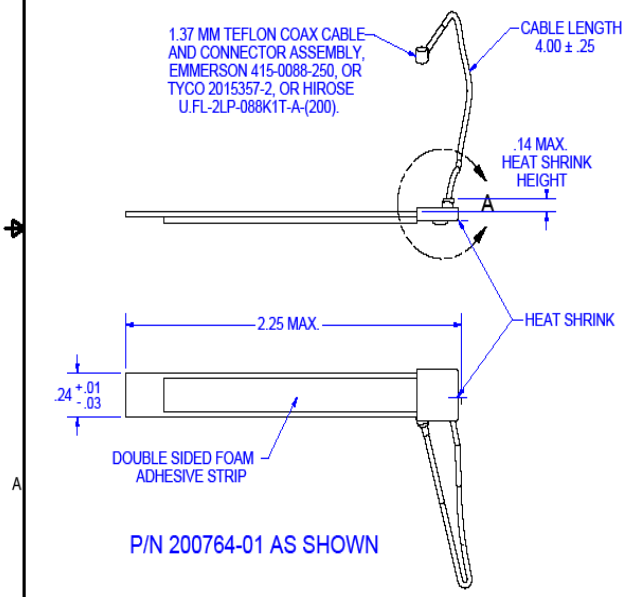
Appendix C
2.4GHz Radio antenna Specification.

NOTES:

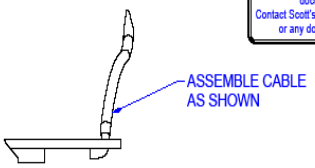
1. DESCRIPTION: EMBEDDED MICROSTRIP ANTENNA.
2. APPLICATION FREQUENCY: 2405 MHz.
3. THIS COMPONENT/ASSEMBLY SHALL BE CERTIFIED THAT IT IS MANUFACTURED IN COMPLIANCE WITH RoHS STANDARD.

REVISION

REV	ECN Nr.	DESCRIPTION	DATE	ENGINEER	CHECKED
A		PRE RELEASE	6/18/2008	J. LANDIS	W. REED
B	129808	Modify Vendor No. from AA02 04841 to OPCP04841, INITIAL RELEASE	10/06/2008	D.THOMPSON	W. REED
C	129960	ADD .14 MAX. HEAT SHRINK HEIGHT NOTE	11/12/2008	D.THOMPSON	W. REED



P/N 200764-01 AS SHOWN



DETAIL A

Notice

This document or information contained within this document resides with a certifying agency. Contact Scott's Certification Group before revising this document or any documentation specified within this document.

SOURCE CONTROL DRAWING

ONLY THE ITEM DESCRIBED ON THIS DRAWING WHEN PROCURED FROM THE VENDOR(S) LISTED HEREON IS APPROVED BY SCOTT HEALTH AND SAFETY, A SCOTT TECHNOLOGIES COMPANY, MONROE, NORTH CAROLINA 28111, FOR USE IN THE APPLICATION(S) SPECIFIED HEREON. A SUBSTITUTE ITEM SHALL NOT BE USED WITHOUT PRIOR TESTING AND APPROVAL BY SCOTT HEALTH AND SAFETY.

APPROVED SOURCE(S) OF SUPPLY

SCOTT P/N	VENDOR	VENDOR ITEM NO.
200764-01	NEARSON INC. 7432 ALBAN STATION BLVD. SUIT B226 SPRINGFIELD, VA 22150 PH: 10703-913-5552	OPCB04841

DRAWN BY	J. LANDIS	6/18/2008
DESIGNED BY	C. PARKULO	6/17/2008
APPROVED BY	W. REED	6/18/2008

DECIMAL .XX ± .01 .XXX ± .005 ANGLE ± 1/2°

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES.

ALL DIMENSIONS AFTER PLATING.

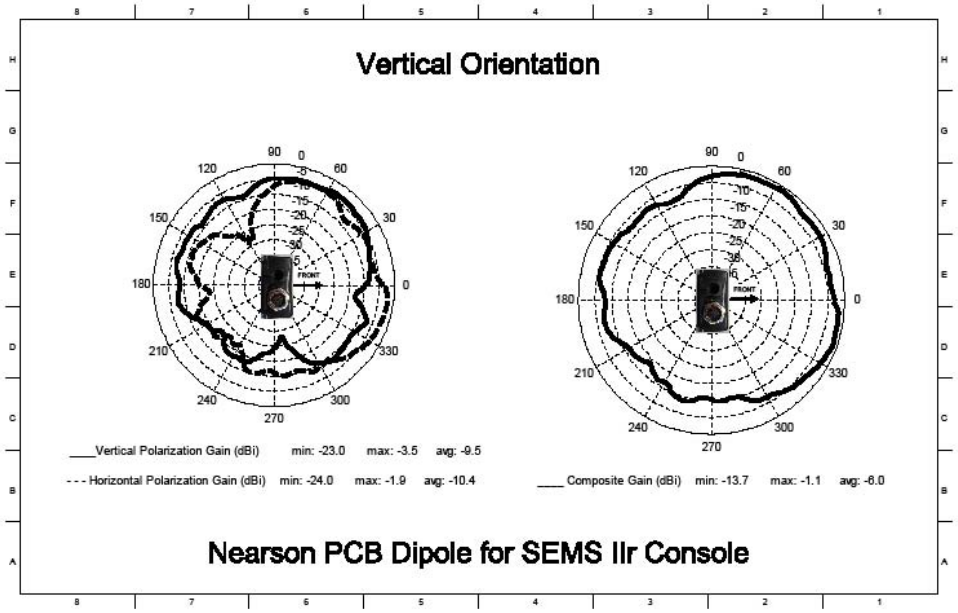
SCOTT®

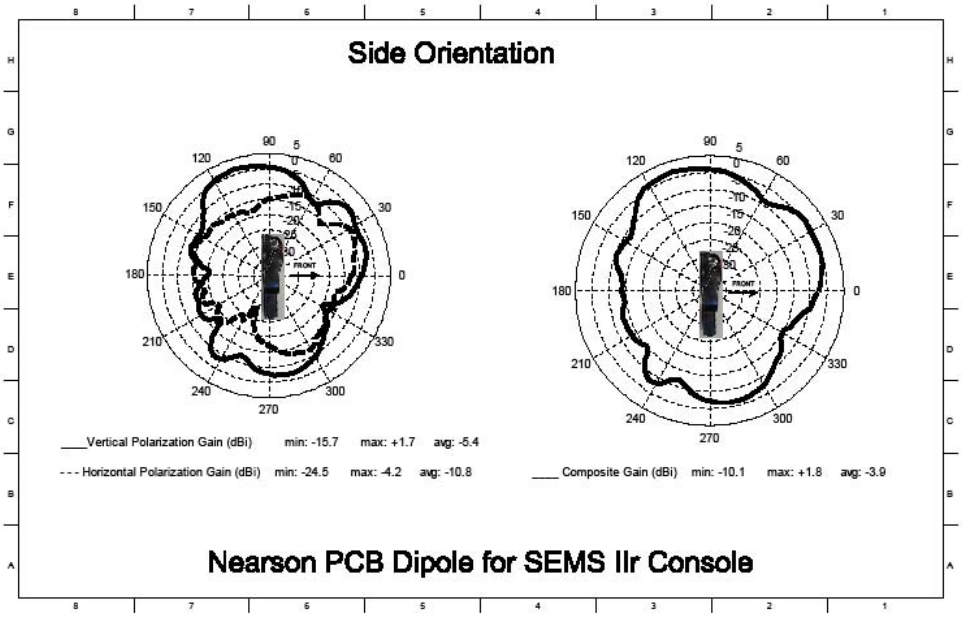
Scott Health and Safety
Monroe Corporate Center
4320 Goldmine Road
Monroe, North Carolina 28110

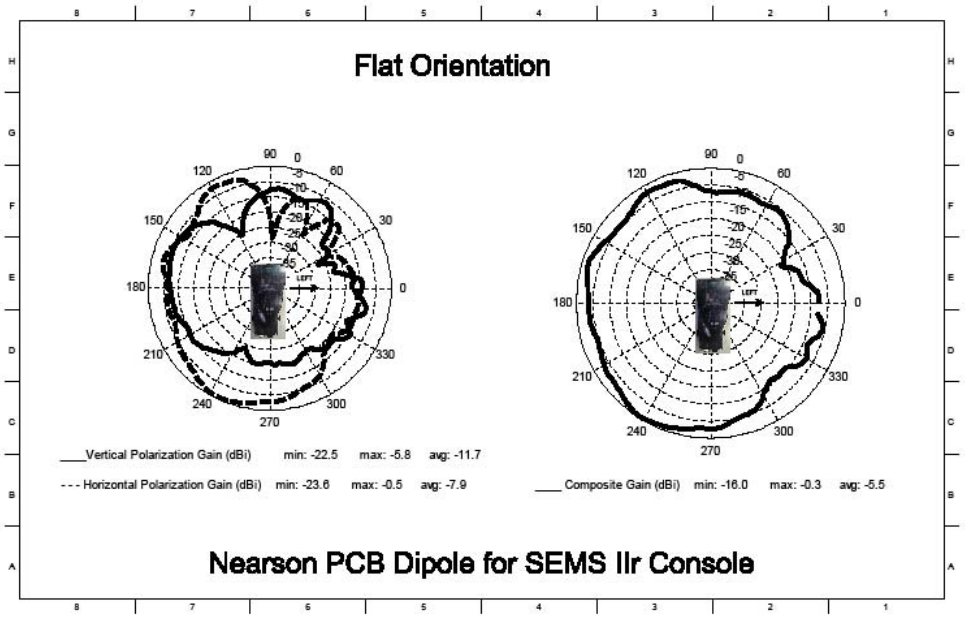
TITLE: ANTENNA

SIZE	CAGE CODE	DRAWING NUMBER	REV
B	15927	200764	C

SCALE 2/1 SHEET 1 OF 1


Vertical Orientation
___Vertical Polarization Gain (dBi) min: -23.0 max: -3.5 avg: -9.5
- - - Horizontal Polarization Gain (dBi) min: -24.0 max: -1.9 avg: -10.4
___ Composite Gain (dBi) min: -13.7 max: -1.1 avg: -8.0
Nearson PCB Dipole for SEMS IIr Console


Side Orientation
___Vertical Polarization Gain (dBi) min: -15.7 max: +1.7 avg: -5.4
- - - Horizontal Polarization Gain (dBi) min: -24.5 max: -4.2 avg: -10.8
___ Composite Gain (dBi) min: -10.1 max: +1.8 avg: -3.9
Nearson PCB Dipole for SEMS IIr Console


Flat Orientation
___Vertical Polarization Gain (dBi) min: -22.5 max: -5.8 avg: -11.7
- - - Horizontal Polarization Gain (dBi) min: -23.6 max: -0.5 avg: -7.9
___ Composite Gain (dBi) min: -16.0 max: -0.3 avg: -5.5
Nearson PCB Dipole for SEMS IIr Console

Appendix D.

Justification for exlusion from SAR testing (Supplied by Manufacturer).

Network Params					
Num Nodes	100				
Absolute Worst Case					
Packet Type	**Size (bytes)**	**Packets/Sec Average**	**Bits/Sec**		**Note**
Status - Own	38	0.03	10.13		Our own status message generated and sent to a neighboring device
Status - Routed (for all of Num Nodes)	48	3.33	1280.00		Worst case size. Accounts for all 100 devices routing through this one.
Ack	16	105.42	13493.33		All unicasts have an Ack, so all packet rates of unicasts messages are included.
M2ORR	48	3	1152.00		Worst case size. Broadcast, max 3 times in one second.
Evac Individual (30 addresses)	120	3.00	2880.00		This is a MAX, and is extremely rarely if ever used. Broadcast, max 3 times in one second.
Withdrawl Ack - Routed Only (for all of Num Nodes)	32	1	256.00		Forced limit from gateway
Alarm Ack - Routed Only (for all of Num Nodes)	32	1	256.00		Forced limit from gateway
Leave Gateway - Own	40	0.05	16.00		This normally done once per incident
Leave Gateway - Routed (for all of Num Nodes)	40	100	32000.00		This normally done once per incident. Would be pretty much impossible to get all 100 leaves at the same node in the same second. The ember radio can only send up to 60 packets per second.
Totals			51343.47		Bits Per Second Transmitted MAX
802.15.4 BPS MAX			250000		
TX Duty Cycle			20.54%	<- THIS IS WITH ALL 100 PEOPLE MANUALLY LEAVING THE NETWORK SIMULTANEOUSLY. WILL NEVER OCCUR IN REAL WORLD SITUATIONS.	
	Size	**Raw Packets >> >>>>>**	>>>>>>>>>>	>>>>>>>>>>	This INCLUDES the Ack, so this is a data/ack combo
Packet Rate/Sec	64	100.2802083			The size here is the average of all the sizes using the size and frequency/period of the packet
Normal Operation					
Packet Type	**Size (bytes)**	**Packets/Sec Average**	**Bits/Sec**		**Note**
Status - Own	38	0.033	10.13		Our own status message generated and sent to a neighboring device
Status - Routed (for all of Num Nodes)	48	3.333	1280.00		Worst case size. Accounts for all 100 devices routing through this one.
Ack	16	3.367	430.93		All unicasts have an Ack, so all packet rates of unicasts messages are included.
M2ORR	48	3	1152.00		Worst case size. Broadcast, max 3 times in one second.
Totals			2873.067		Bits Per Second Transmitted MAX
802.15.4 BPS MAX			250000		
TX Duty Cycle			1.15%	<- NORMAL NETWORK TRAFFIC WITH PERIODIC STATUS CHECKS	
	Size	**Raw Packets >> >>>>>**	>>>>>>>>>>	>>>>>>>>>>	This INCLUDES the Ack
Packet Rate/Sec	64	5.611458333			The size here is the average of all the sizes using the size and frequency/period of the packet

Explanation of SAR Duty Cycle Calculations

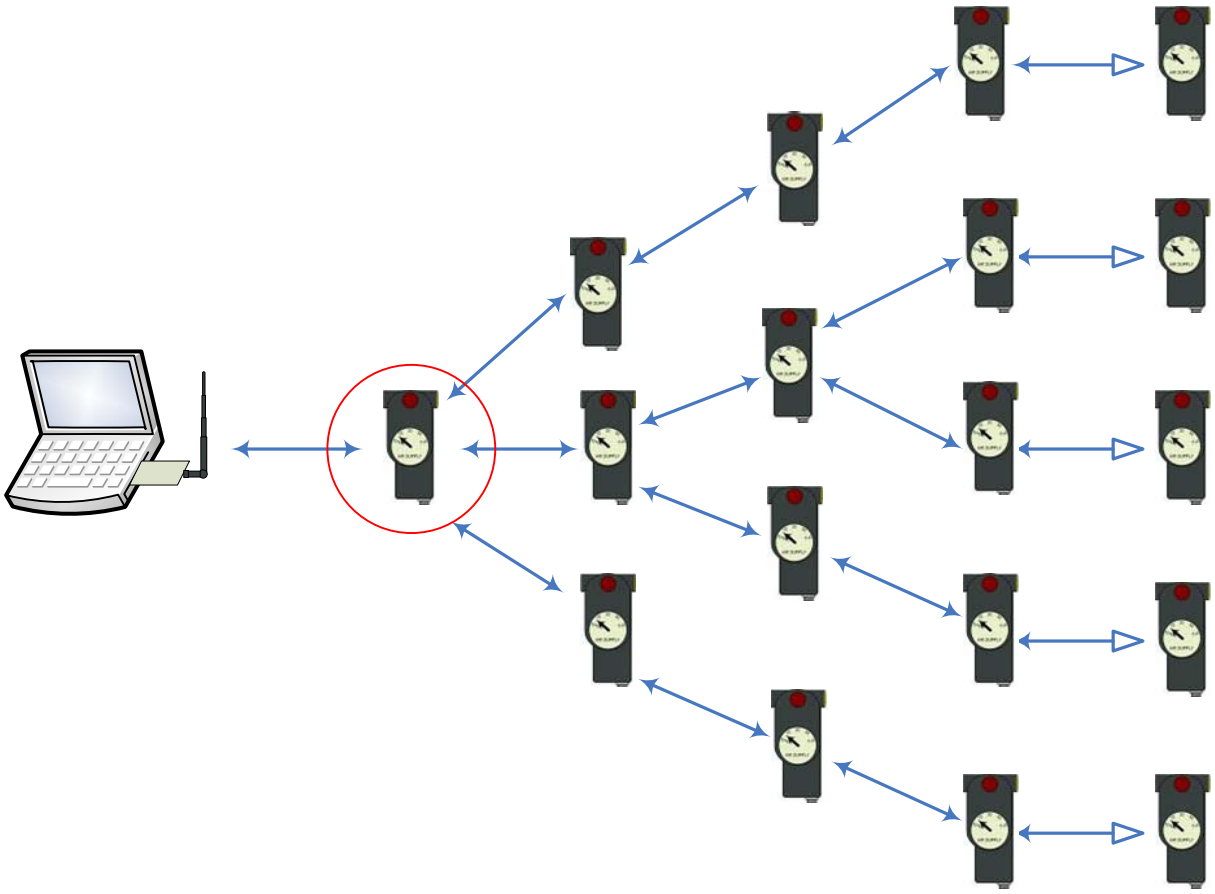
Summary

This spreadsheet and explanation of said spreadsheet shows what the absolute peak possible rate of transmit that can come out of a node during any second. This is a theoretical max rate for a 1 second period, and thus the average rate over several seconds would be MUCH lower. This rate is a worst cast average such that it is the worst rate possible in the network at any once second. In addition, this theoretical second is extremely unlikely to ever occur in the first place. The goal is to show we are WELL below any required TX duty cycle for the system to pass SAR testing by at least an order of magnitude.

Configurable Parameter:

Num Nodes: this is the maximum number of devices in the network. This value was originally specified as 200, however it has been reduced to 100. This number determines linearly how much traffic is pumped into the gateway, and thus how much traffic (equal) could be run through a routing device in the worst case scenario, which is all traffic to the gateway.

Worst Case System Definition



This picture illustrates how the worst case network forms. The laptop is the Gateway, and the black devices are the Pack Units worn by firefighters. All devices in this diagram MUST route all data to and from the Gateway/Coordinator through the device with the red circle around it. The hollow arrows represent paths to nodes not in the drawing, but assumed to be there. This worst case would have a total of 100 nodes. All worst case numbers and explanations are based on this diagram and this network scenario.

Two Sets of Calculations

There are two sets of calculations run. The first is a theoretical worst case that would be for the worst second possible in this system; however this would only be for a single second in which this worst case would occur, then the system would return to the normal/average case quickly after this worst case peak.

The second is the normal/average case, which is the transmit rates you get after averaging all transmissions over a period of time.

Explanation of Columns in the Calculations

All packets listed here are being "generated or forwarded" by the node that is considered the busiest in the system in terms of Transmit in the worst case scenario. What is transmitted is summed in bits per second to determine what the duty cycle is.

1. Packet Type: This is the type of mess that a node can transmit

2. Size (Bytes): This is the number of bytes in this type of packet. If variable length packets are possible, then the worst case number is used.
3. Packets/Sec Average: This number is the frequency of this type of packet in the system shown as an average. This is a worst case packet rate that any one node could see.
4. Bits/Sec: This is simply bytes that a node can send in a single second = bytes * 8 * packets/sec.
5. Note: This gives some information about the numbers in that row.

Explanation of Packet Types and Sizes

The following tables contain additional information about the packet types listed in the calculations that may need to be known, or may help understand the calculations better. The first table is a definition of the message and how it occurs. The second table provides additions information on each message. Unicast means it is only addressed to one device, and only one device will process it, and only one device will respond to it with an Ack to acknowledge the receipt of the message. The Broadcast message is not specifically addressed, and thus is processed by every node. There are no Acks with a broadcast. Broadcasts are forwarded (in most cases) by each node 3 times. Nodes only forward the same message 1 set of three times even if they hear the same message from many nodes. Thus, each node in the network forwards a single broadcast 3 times. Therefore if there are 10 nodes in a network, and 1 of those nodes sends a broadcast, it sends it 3 times, then each node hearing that sends it 3 times, repeating until all nodes have sent it 3 times for a total of 30 individual transmissions.

Packet Type	**Definition**
Status - Own	This message is the periodic status message for each node in the network. It is sent on a periodic basis. It is a unicast message.
Status - Routed	This is the same as that above, however these are status messages being routed for other nodes, from other nodes, to the gateway. It is a unicast message. Routed status information can occasionally contain route information for up to 6 hops out which adds an extra 10 bytes to the message max.
Ack	This is a message that is sent in response to the successful receipt of a unicast message. It is only sent on a link from one neighboring device to another and is not propagated over multiple hops.
M2ORR	This is a Many-to-One-Route-Request. It is a broadcast sent from the gateway to all devices. It is sent to generate a route to all devices in the network. Each hearing device adds its address to the broadcast (two extra bytes) before sending it on. It also chooses the best of all received messages which is the shortest list, and best receive strength on hearing. As this propagates out in broadcast style, it allows all devices to know the route to the gateway.
Evac Individual	This is a message with a list from 1 up to 30 2-byte addresses. It is a broadcast sent from the gateway to all devices.
Withdrawal Ack	This is a unicast message sent in response to a value in the status message being sent. It is sent from the gateway to an individual device.
Alarm Ack	This is a unicast message sent in response to a value in the status message being sent. It is sent from the gateway to an individual device.
Leave Gateway - Own	This is sent from a device to the gateway when a user presses a button to

	turn its unit off. It is a unicast.
Leave Gateway - Routed	This is the same as that above, however these are leave gateway messages being routed for other nodes, from other nodes, to the gateway. It is a unicast message.

N = Number of Nodes up to 100 MAX.
GW = Gateway

Packet Type	**Bytes Min**	**Bytes Max**	**Rate of Transmit**
Status - Own	38	38	1 every 30 seconds
Status - Routed	38	48	1 * N every 30 seconds
Ack	32	32	1 for every unicast sent
M2ORR	32	42	1 broadcast every 20 seconds
Evac Individual	34	92	When a user pushes an Evac button at the GW. Forced to 10 second spacing.
Withdrawal Ack	32	32	1 per second MAX
Alarm Ack	32	32	1 per second MAX
Leave Gateway - Own	40	40	1 per incident
Leave Gateway - Routed	40	40	Up to 100 in a single incident, but in theory could occur in the same second, which is essentially impossible.

Summations

The column of Bits/Sec is summed. This becomes all of the worst case rates of all types of packets that can be transmitted from any one node in the system. That number is then divided by the raw bit rate of the radio to arrive at the TX Duty Cycle.

Results

This number is a result of summing all worst case scenarios, which individually are extremely unlikely to ever occur in any one second, and this the summation of all worse case scenarios is astronomically unlikely to ever occur in a single second.
In the terms of this system, the largest effects are:

1. All devices send status at a time such that all of the status messages arrive at a single point in the system in the same second. Since status messages are sent every 30 seconds, and are completely random, it is essentially impossible for this to occur.
2. All devices send status at a time such that all of the leave gateway messages arrive at a single point in the system in the same second. Since this requires a button push when logging off when done with an incident, it would require users to be synchronized in their pushing of the button, which is essentially not going to ever occur in the real world.

Last, it is critical to note that if running averages exceeding 1 second where done, we could show that the duty cycle is even less.
So, with our number coming in at just over 20% for the peak rate, and the normal/average rate of 1.2%, the results are acceptable for SAR.

Screen Captures

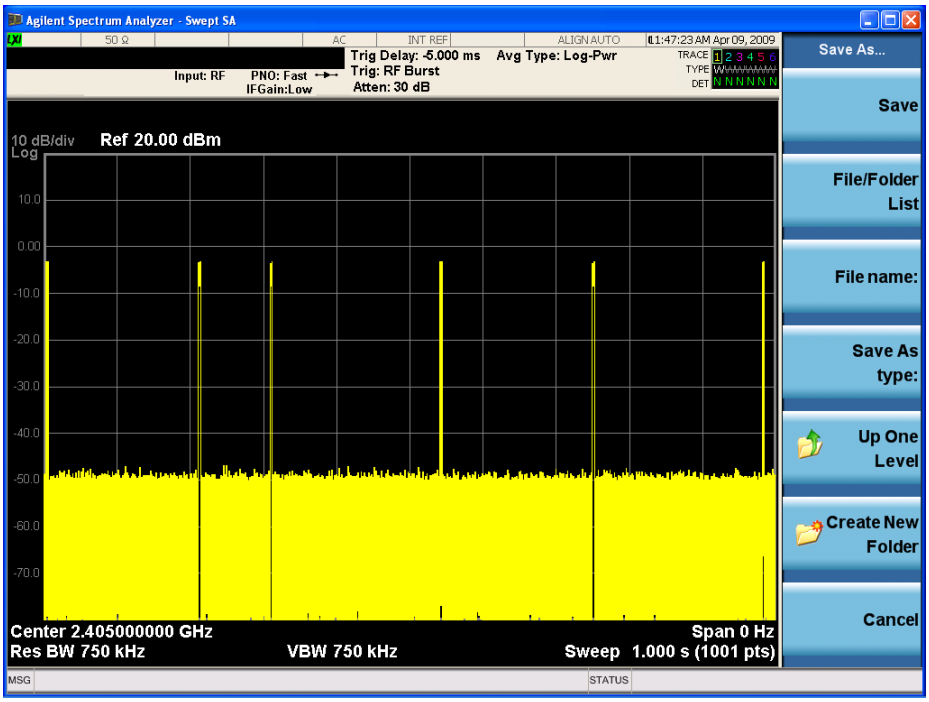


Figure 1. Normal message traffic in a 1 second period.

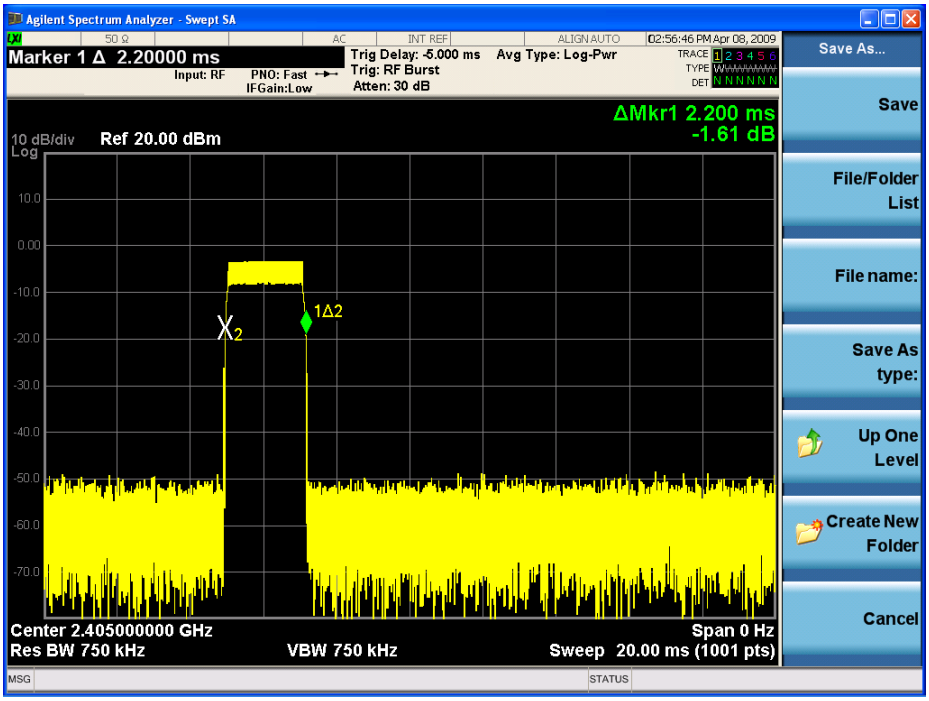


Figure 2. Status message.

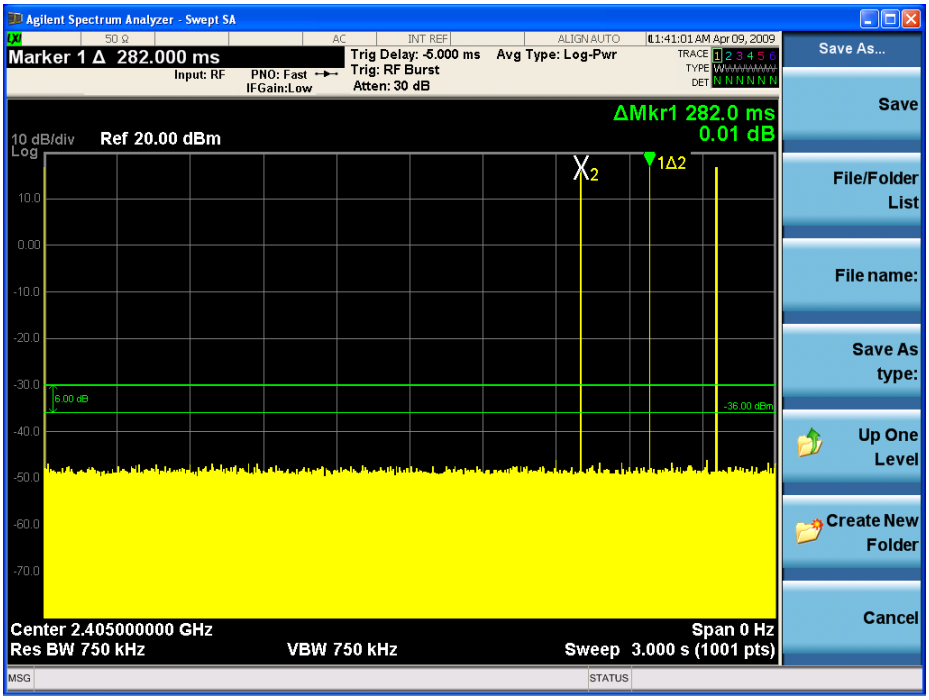


Figure 3. Route Request (M2ORR).

1. Power threshold for SAR exclusion.

F(GHz) Low	F(GHz) High	Center of Tunable Band (GHz)	FCC Limitation based on center of band (mW)
2405.0	2405.0	2405.0	24.95

2. Maximum measured transmitter power.

   Pout (Conducted) = 19.0 dBm = 79.43 mW
   Source Based Time Average Power (Worst case) = 0.2054 X 79.43 = 16.31 mW

Source Based Time Averaged power (mW)	Maximum Antenna Gain (dBi)	Pout EIRP (mW)
16.31	1.80	**24.69**

3. Conclusion.

The threshold for exclusion from SAR evaluation is 24.95mW for FCC and since the SEMS II has a maximum transmitted power of **24.69** mW no SAR evaluation is required.

4. MPE calculation

The following MPE calculations are based on an internal PCB dipole antenna with a measured ERP of 113.4 dBuV/m (at 3 meters) and conducted RF power of +19.0 dBm. The source based time averaged conducted RF power as presented to the antenna is 16.31 mW or 12.12 dBm (worst case). The maximum gain of this antenna, based on the data sheet is +1.8 dBi.

Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density
P = power input to the antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal:	12.12	(dBm)
Maximum peak output power at antenna input terminal:	16.293	(mW)
Antenna gain(typical):	1.8	(dBi)
Maximum antenna gain:	1.514	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	2405	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	1	(mW/cm^2)
Power density at prediction frequency:	0.004906	(mW/cm^2)
Maximum allowable antenna gain:	24.9	(dBi)
Margin of Compliance at 20 cm =	23.1	dB

Appendix E.

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