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Test Report

Certification

Test Of: TMD-15

FCC ID: AMS972321333

Test Specification:
FCC PART 15, Subpart C

Test Report Serial No: 203788-3.1

Applicant:
Xandem Technologies, LLC
211 East 300 South, Suite 208
Salt Lake City, UT 84111

Dates of Test: March 20 & 21, 2012

Issue Date: April 12, 2012

Accredited Testing Laboratory By:



NVLAP Lab Code 100272-0

CERTIFICATION OF ENGINEERING REPORT

This report has been prepared by Nemko-CCL, Inc. to document compliance of the device described below with the requirements of Federal Communications Commission (FCC) Part 15, Subpart C. This report may be reproduced in full, partial reproduction may only be made with the written consent of the laboratory. The results in this report apply only to the sample tested.

- Applicant: Xandem Technologies, LLC
- Manufacturer: Xandem Technologies, LLC
- Brand Name: Xandem
- Model Number: TMD-15
- FCC ID Number: AMS972321333

On this 12th day of April 2012, I, individually and for Nemko-CCL, Inc., certify that the statements made in this engineering report are true, complete, and correct to the best of my knowledge, and are made in good faith.

Although NVLAP has recognized that the Nemko-CCL, Inc. EMC testing facilities are in good standing, this report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government.

Nemko-CCL, Inc.



Tested by: Norman P. Hansen
EMC Technician

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SECTION 1.0 CLIENT INFORMATION

1.1 Applicant:

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211 East 300 South, Suite 208
Salt Lake City, UT 84111

Contact Name: Joey Wilson
Title: CEO

1.2 Manufacturer:

Company Name: Xandem Technologies, LLC
211 East 300 South, Suite 208
Salt Lake City, UT 84111

Contact Name: Joey Wilson
Title: CEO

SECTION 2.0 EQUIPMENT UNDER TEST (EUT)**2.1 Identification of EUT:**

Brand Name: Xandem
 Model Number: TMD-15
 Serial Number: Preproduction Unit
 Country of Manufacture: U.S.A.

2.2 Description of EUT:

TMD-15 is an 802.15.4 transceiver that is used in a motion detection and monitoring system. Multiple TMD-15 units communicate with another TMD-15 that is used as the processing unit that interfaces the security system via the contact input ports of the security system controller. The antenna is a trace on the PCB with a maximum gain of 3.3 dBi. The TMD-15 was powered by 2 AA batteries or 5 VDC from a Sino American R4W005-100 power supply.

The TMD-15 uses 78 channels in the 2400 – 2483.5 MHz frequency band. See the table of channels below. The TMD-15 channels to be used in the system are programmed by the installer to get proper coverage and avoid other radios operating in the 2400 MHz to 2483.5 MHz frequency band.

Channel	Frequency (MHz)						
1	2403	21	2423	41	2443	61	2463
2	2404	22	2424	42	2444	62	2464
3	2405	23	2425	43	2445	63	2465
4	2406	24	2426	44	2446	64	2466
5	2407	25	2427	45	2447	65	2467
6	2408	26	2428	46	2448	66	2468
7	2409	27	2429	47	2449	67	2469
8	2410	28	2430	48	2450	68	2470
9	2411	29	2431	49	2451	69	2471
10	2412	30	2432	50	2452	70	2472
11	2413	31	2433	51	2453	71	2473
12	2414	32	2434	52	2454	72	2474
13	2415	33	2435	53	2455	73	2475
14	2416	34	2436	54	2456	74	2476
15	2417	35	2437	55	2457	75	2477
16	2418	36	2438	56	2458	76	2478

Channel	Frequency (MHz)						
17	2419	37	2439	57	2459	77	2479
18	2420	38	2440	58	2460	78	2480
19	2421	39	2441	59	2461		
20	2422	40	2442	60	2462		

This report covers the circuitry of the devices subject to FCC Part 15, Subpart C. The circuitry of the device subject to FCC Part 15, Subpart B has been tested to FCC Subpart B and found to comply. Compliance is shown Nemko-CCL report #203788-2.1.

2.3 EUT and Support Equipment:

The FCC ID numbers for the EUT and support equipment used during the test are listed below:

Brand Name Model Number Serial No.	FCC ID Number / Compliance	Description	Name of Interface Ports / Interface Cables
BN: Xandem MN: TMD-15 (Note 1) SN: Preproduction Unit	AMS972321333	Tomographic Motion Detector	See Section 2.4

Note: (1) EUT

2.4 Interface Ports on EUT:

Name of Ports	No. of Ports Fitted to EUT	Cable Descriptions/Length
DC In	1	2 unshielded conductors from power source/10 cm or 25 feet
Contact (A and B)	2	2 unshielded conductors per port/1 meter
Mini USB	0	Debugging port only
Card Edge Connector	0	Used only for programming the device

2.5 Modification Incorporated/Special Accessories on EUT:

The following modifications were made to the TMD-15 by the Client during testing to comply with the specification. This report is not complete without an accompanying signed attestation, included as Appendix 3, that the product will have all of the documented modifications incorporated into the product when manufactured and placed on the market.

1. The EUT power setting in software for channel 78 at 2480 MHz was reduced from 255 to 205. Channels 1 – 77 have the software setting at 255.

SECTION 3.0 TEST SPECIFICATION, METHODS & PROCEDURES

3.1 Test Specification:

Title: FCC PART 15, Subpart C (47 CFR 15)
15.203, 15.207, and 15.247

Limits and methods of measurement of radio interference
characteristics of radio frequency devices

Purpose of Test: The tests were performed to demonstrate initial compliance

3.2 Methods & Procedures:

3.2.1 §15.203 Antenna Requirement

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

3.2.2 §15.207 Conducted Limits

(a) Except for Class A digital devices, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the band edges.

Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	Quasi-peak	Average
0.15 – 0.5*	66 to 56*	56 to 46*
0.5 – 5	56	46
5 - 30	60	50

*Decreases with the logarithm of the frequency.

3.2.3 §15.247 Operation within the bands 902 – 928 MHz, 2400 – 2483.5 MHz, and 5725 – 5850 MHz

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400 – 2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudorandomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

(ii) Frequency hopping systems operating in the 5725-5850 MHz band shall use at least 75 hopping frequencies. The maximum 20 dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 non-overlapping channels. The average time of occupancy on any

channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 non-overlapping channels are used.

(2) Systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

(b) The maximum peak output power of the intentional radiator shall not exceed the following:

(1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

(2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725 - 5850 MHz bands: 1 watt. As an alternative to a peak power measurement, compliance with the Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(c) Operation with directional antenna gains greater than 6 dBi.

(1) Fixed point-to-point operation:

(i) Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

(ii) Systems operating in the 5725-5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

(iii) Fixed, point-to-point operation, as used in paragraphs (b)(4)(i) and (b)(4)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum or digitally modulated intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

(2) In addition to the provisions in paragraphs (b)(1), (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400-2483.5 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:

(i) Different information must be transmitted to each receiver.

(ii) If the transmitter employs an antenna system that emits multiple directional beams but does not emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, i.e., the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna /antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:

(A) The directional gain shall be calculated as the sum of $10 \log$ (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.

(B) A lower value for the directional gain than that calculated in paragraph (c)(2)(ii)(A) of this section will be accepted if sufficient

evidence is presented, e.g., due to shading of the array or coherence loss in the beamforming.

(iii) If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the power limit specified in paragraph (c)(2)(ii) of this section. If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the limit specified in paragraph (c)(2)(ii) of this section. In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the limit specified in paragraph (c)(2)(ii) of this section by more than 8 dB.

(iv) Transmitters that emit a single directional beam shall operate under the provisions of paragraph (c)(1) of this section.

(d) 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 least 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, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

(e) For digitally modulated 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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

(f) For the purposes of this section, hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques. The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4. The digital modulation operation of the hybrid system, with the frequency hopping turned off, shall comply with the power density requirements of paragraph (d) of this section.

(g) Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

(h) The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

(i) Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See § 1.1307(b)(1) of this Chapter.

Note: Spread spectrum systems are sharing these bands on a noninterference basis with systems supporting critical Government requirements that have been allocated the usage of these bands, secondary only to ISM equipment operated under the provisions of Part 18 of this Chapter. Many of these Government systems are airborne radiolocation systems that emit a high EIRP which can cause interference to other users. Also, investigations of the effect of spread spectrum interference to U. S. Government operations in the 902-928 MHz band may require a future decrease in the power limits allowed for spread spectrum operation.

3.3 Test Procedure

The conducted disturbance at mains ports and radiated disturbance testing was performed according to the procedures in ANSI C63.4: 2003 and using the guidance, Measurement of Digital Transmission Systems Operating under Section 15.247, dated March 23, 2005. Testing was performed at Nemko-CCL, Inc. Wanship open area test site #2, located at 29145 Old Lincoln Highway, Wanship, UT. This site has been fully described in a report submitted to the FCC, and was accepted in a letter dated February 15, 2012 (90504).

Nemko-CCL, Inc. is accredited by National Voluntary Laboratory Accreditation Program (NVLAP); NVLAP Lab Code: 100272-0, which is effective until September 30, 2012.

For radiated emission testing at 30 MHz or above that is performed at distances closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

SECTION 4.0 OPERATION OF EUT DURING TESTING

4.1 Operating Environment:

Power Supply: 3 VDC from 2 AA batteries or 5 VDC from Sino American R4W005-100 power supply

4.2 Operating Modes:

The transmitter was tested while in a constant transmit mode at the maximum power setting of 255 for channels 1, 58, and 77 and at a power setting of 205 at channel. The AC mains voltage was varied as required by §15.31(e) with no change seen in the voltage supplied to the transmitter or in transmitter characteristics. New batteries were used for testing with the EUT powered by batteries. A Sino-American R4W005-100 power supply was used to power the EUT for conducted emissions at the AC mains. The worst-case radiated emissions were seen when the EUT was placed flat on the table and powered by the external power supply.

4.3 EUT Exercise Software:

Xandem test software was used to exercise the transmitter.

SECTION 5.0 SUMMARY OF TEST RESULTS**5.1 FCC Part 15, Subpart C****5.1.1 Summary of Tests:**

Section	Environmental Phenomena	Frequency Range (MHz)	Result
15.203	Antenna Requirements	Structural requirement	Complied
15.207	Conducted Disturbance at Mains Ports	0.15 to 30	Complied
15.247(a)	Bandwidth Requirement	2425 – 2480	Complied
15.247(b)	Peak Output Power	2425 – 2480	Complied
15.247(c)	Spurious Emissions	30 - 24800	Complied
15.247(d)	Peak Power Spectral Density	2425 – 2480	Complied
15.247(e)	Reserved Paragraph	N/A	Not Applicable
15.247(f)	Hybrid System Requirements	2400 – 2483.5	Not Applicable
15.247(g)	Frequency Hopping Channel Usage	2400 – 2438.5	Not Applicable
15.247(h)	Frequency Hopping Intelligence	2400 – 2483.5	Not Applicable

5.2 Result

In the configuration tested, the EUT complied with the requirements of the specification.

SECTION 6.0 MEASUREMENTS, EXAMINATIONS AND DERIVED RESULTS**6.1 General Comments:**

This section contains the test results only. Details of the test methods used and a list of the test equipment used during the measurements can be found in Appendix 1 of this report.

6.2 Test Results:**6.2.1 §15.203 Antenna Requirements**

The EUT uses a trace antenna on the PCB and the antenna cannot be replaced or modified by the user.

6.2.2 §15.207 Conducted Disturbance at the AC Mains Ports

Frequency (MHz)	AC Mains Lead	Detector	Measured Level (dBμV)	Limit (dBμV)	Margin (dB)
0.16	Hot Lead	Peak (Note 1)	52.0	55.5	-3.5
0.21	Hot Lead	Peak (Note 1)	49.3	53.1	-3.8
0.25	Hot Lead	Peak (Note 1)	47.6	51.7	-4.1
0.29	Hot Lead	Peak (Note 1)	46.4	50.6	-4.2
0.33	Hot Lead	Peak (Note 1)	46.0	49.6	-3.6
0.44	Hot Lead	Peak (Note 1)	41.4	47.0	-5.6
0.15	Neutral Lead	Quasi-Peak (Note 1)	47.0	56.0	-9.0
0.19	Neutral Lead	Peak (Note 1)	48.6	53.9	-5.3
0.21	Neutral Lead	Peak (Note 1)	49.7	53.1	-3.4
0.28	Neutral Lead	Peak (Note 1)	46.8	50.9	-4.1
0.33	Neutral Lead	Peak (Note 1)	42.9	49.3	-6.4
0.38	Neutral Lead	Peak (Note 1)	42.5	48.2	-5.7
0.45	Neutral Lead	Peak (Note 1)	40.5	46.9	-6.4

Note 1: The reference detector used for the measurements was Quasi-Peak or Peak and the data was compared to the average limit; therefore, the EUT was deemed to meet both the average and quasi-peak limits.

RESULT

The EUT complied with the specification by 3.4 dB.

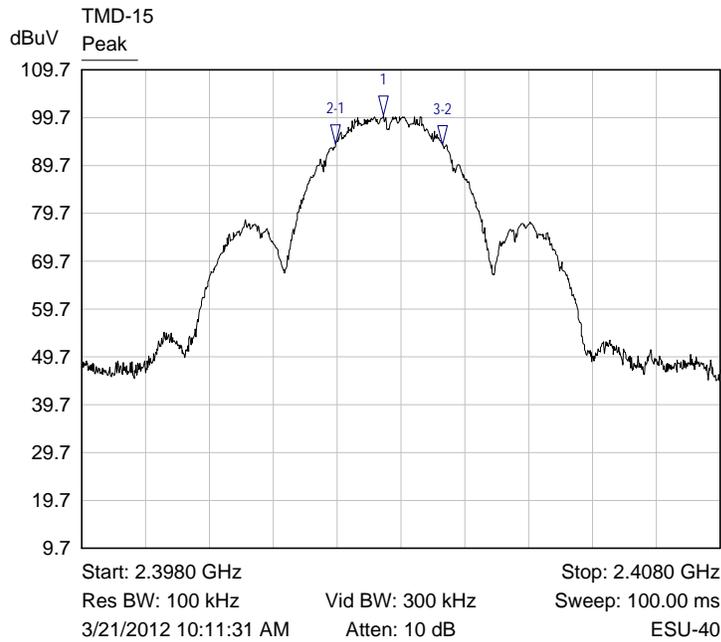
6.2.3 §15.247(a)(2) Emission Bandwidth

Frequency (MHz)	Emission 6 dB bandwidth (kHz)
2403	1670
2440	1600
2480	1650

RESULT

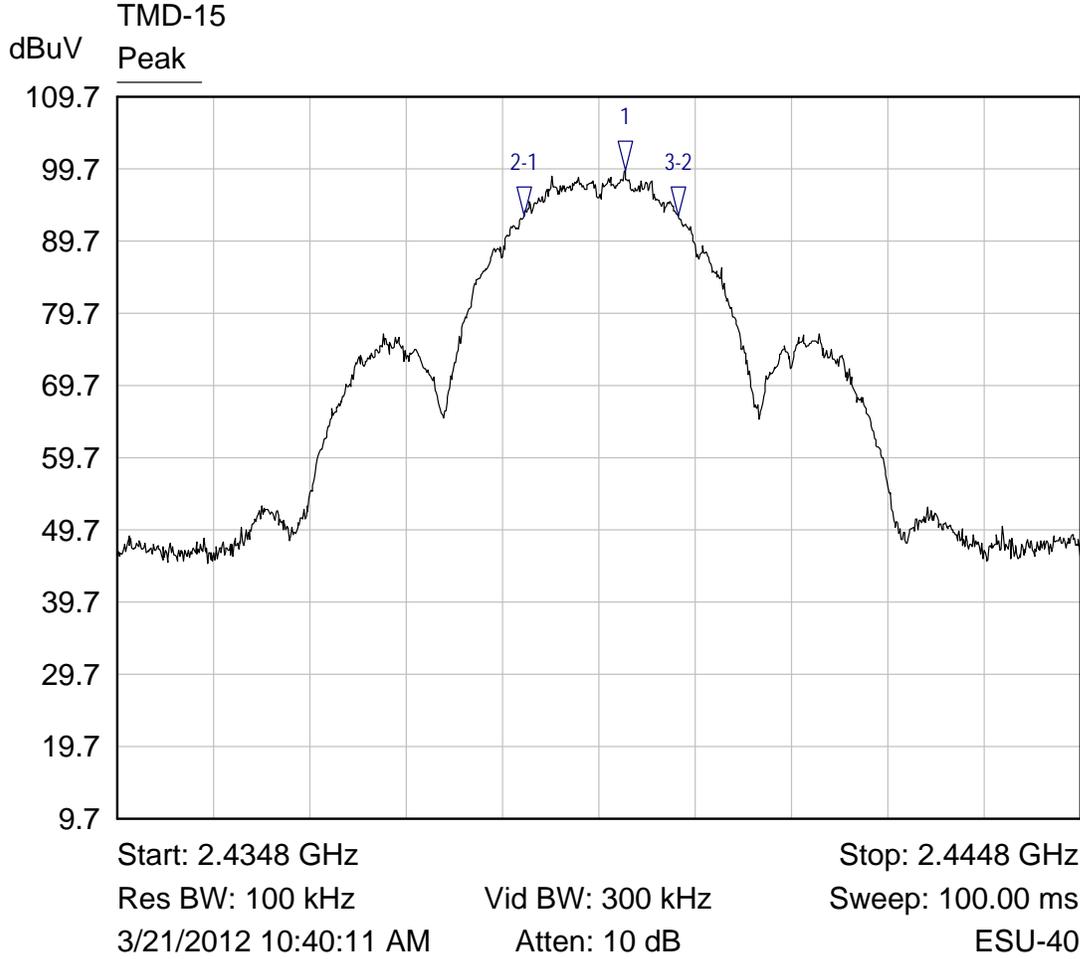
In the configuration tested, the 6 dB bandwidth was greater than 500 kHz; therefore, the EUT complied with the requirements of the specification (see spectrum analyzer plots below).

Lowest Channel Bandwidth



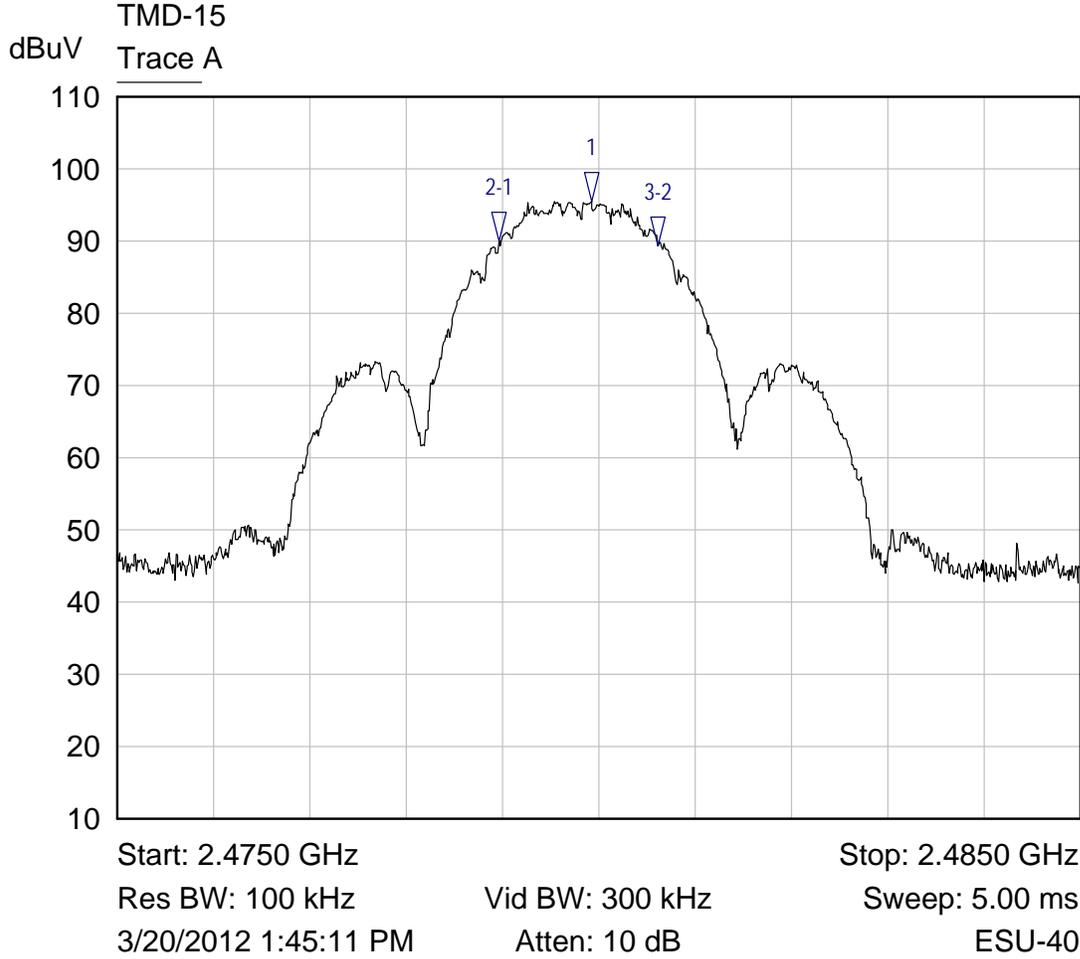
Mkr	Trace	X-Axis	Value	Notes
1 ▾	Peak	2.4027 GHz	100.14 dBuV	
2-1 ▾	Peak	-750.0000 kHz	-5.96 dB	
3-2 ▾	Peak	1.6700 MHz	-0.07 dB	

Middle Channel Bandwidth



Mkr	Trace	X-Axis	Value	Notes
1 ▾	Peak	2.4401 GHz	99.52 dBuV	
2-1 ▾	Peak	-1.0500 MHz	-6.31 dB	
3-2 ▾	Peak	1.6000 MHz	-0.03 dB	

Upper Channel Bandwidth



Mkr	Trace	X-Axis	Value	Notes
1 ▾	Trace A	2.4799 GHz	95.50 dBuV	
2-1 ▾	Trace A	-960.0000 kHz	-5.53 dB	
3-2 ▾	Trace A	1.6500 MHz	-0.68 dB	

6.2.4 §15.247(b)(3) Peak Output Power

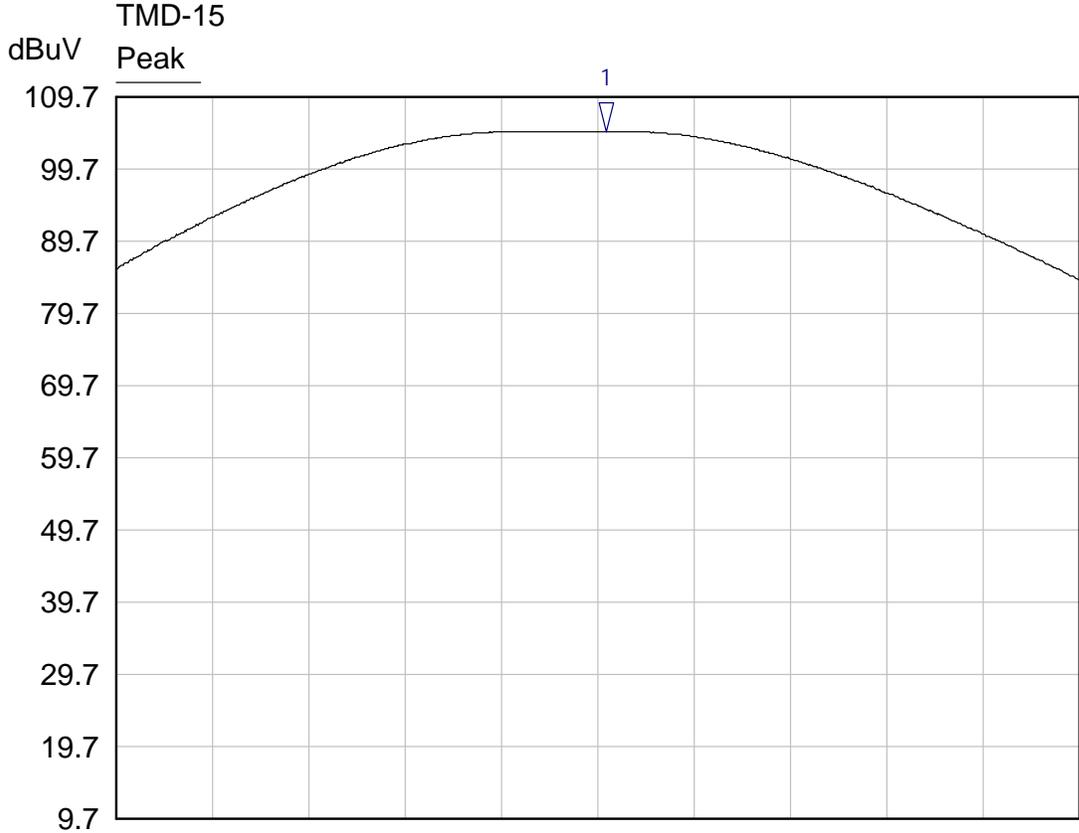
The EUT uses a trace antenna on the PCB that has a maximum gain of 3.3 dBi, or a numeric gain of 2.14. The limit for this device is 30 dBm or 1 Watt. The maximum field strength was measured at a distance of 3 meters. Then the field strength was converted to Peak Conducted Output Power and that value was compared to the limit of 30 dBm or 1 Watt. Plots are shown below and the results of this testing are summarized in the table.

Frequency (MHz)	Measured Field Strength (dB μ V/m)	Calculated Output Power to the Antenna (mW)
2403	104.92	4.35
2440	103.13	2.88
2480	100.69	1.64

RESULT

In the configuration tested, the RF peak output power was less than 1 Watt; therefore, the EUT complied with the requirements of the specification (see spectrum analyzer plots below).

Lowest Channel



Start: 2.3980 GHz Stop: 2.4080 GHz
 Res BW: 3 MHz Vid BW: 10 MHz Sweep: 100.00 ms
 3/21/2012 10:10:42 AM Atten: 10 dB ESU-40

Mkr	Trace	X-Axis	Value	Notes
1 ▽	Peak	2.4031 GHz	104.92 dBuV	

6.2.5 §15.247(c) Spurious Emissions

The frequency range from 30 MHz to 24.75 GHz was investigated to measure any radiated emissions. Any emissions in the restricted bands must meet the limits specified in §15.209. Emissions outside the restricted bands must be attenuated 20 dB below the highest power level measured within the authorized band as measured with a 100 kHz RBW; the highest level measured was 101.62 dB μ V/m; therefore, the criteria is 101.62 – 20.0 = 81.62 dB μ V/m. The tables show the worst-case emissions measured from the TMD-15. Note that the emissions, even those not in restricted bands, were compared to, and found to comply with the limits of §15.209. Band edge plots are also shown.

Average Factor Calculations

An averaging factor was applied to the average measurements made on emissions above 1 GHz that demonstrated the same characteristics as the fundamental frequency. The calculations are shown below.

IEEE 802.15.4-2003 2.4 GHz PHY Constants

Data Rate	250000	bits / sec	
	31250	bytes / sec	
Symbols/byte	2	sym / bytes	
Symbol Timing	62500	sym / sec	
	0.000016	sec / sym	
Byte Timing	0.000032	sec / byte	
PHY PSDU	6	bytes	4 Preamble, SPD, Length
Max Length	127	bytes	
Total Packet Length	133	bytes	
Maximum Time TX PKT	0.004256	sec	

Total Transmit Time (Pon) = 0.004256 sec

Minimum off Time (Poff) = 0.005864 sec

Total Time (Ptotal) 0.01012 (0.004256 + 0.005864)

Averaging Factor = 20 log (Pon / Ptotal)
 = 20 log (0.004256 / 0.01012)
 = -7.5 dB

RESULT

All spurious emissions, even those in the restricted bands of §15.205, met the limits specified in §15.209; therefore, the EUT complies with the specification.

Transmitting at the Lowest Frequency (2403 MHz)

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dB μ V)	Correction Factor (dB)	Averaging Factor (dB)	Field Strength (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
4806.0	Peak	Vertical	13.5	37.7	0.0	51.2	74.0	-22.8
4806.0	Average	Vertical	10.9	37.7	-7.5	41.1	54.0	-12.9
4806.0	Peak	Horizontal	19.4	37.7	0.0	57.1	74.0	-16.9
4806.0	Average	Horizontal	15.9	37.7	-7.5	46.1	54.0	-7.9
7209.0	Peak	Vertical	18.9	42.1	0.0	61.0	74.0	-13.0
7209.0	Average	Vertical	5.8	42.1	-7.5	40.4	54.0	-13.6
7209.0	Peak	Horizontal	23.2	42.1	0.0	65.3	74.0	-8.7
7209.0	Average	Horizontal	10.1	42.1	-7.5	44.7	54.0	-9.3
9612.0	Peak	Vertical	9.3	44.7	0.0	54.0	74.0	-27.6
9612.0	Average	Vertical	3.3	44.7	-7.5	40.5	54.0	-21.1
9612.0	Peak	Horizontal	14.6	44.7	0.0	59.3	74.0	-22.3
9612.0	Average	Horizontal	1.6	44.7	-7.5	38.8	54.0	-22.8
12015.0	Peak	Vertical	5.3	47.2	0.0	52.5	74.0	-21.5
12015.0	Average	Vertical	-3.6	47.2	-7.5	36.1	54.0	-17.9
12015.0	Peak	Horizontal	6.3	47.2	0.0	53.5	74.0	-20.5
12015.0	Average	Horizontal	-1.7	47.2	-7.5	38.0	54.0	-23.6
14418.0	Peak	Vertical	-0.3	50.8	0.0	50.5	74.0	-23.5
14418.0	Average	Vertical	-11.7	50.8	-7.5	31.6	54.0	-22.4
14418.0	Peak	Horizontal	-0.1	50.8	0.0	50.7	74.0	-23.3
14418.0	Average	Horizontal	-11.7	50.8	-7.5	31.6	54.0	-22.4

Transmitting at the Middle Frequency (2440 MHz)

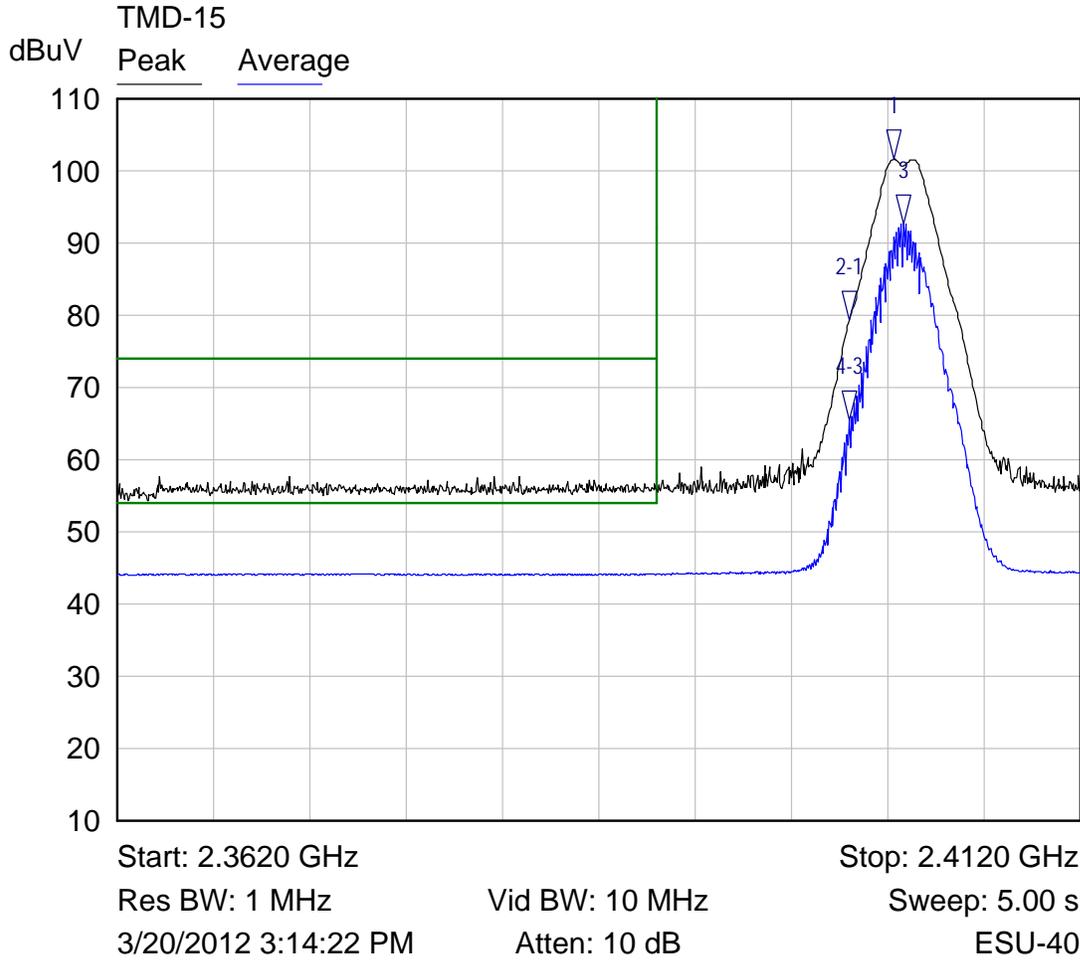
Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Averaging Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
4880.0	Peak	Vertical	16.3	37.9	0.0	54.2	74.0	-19.8
4880.0	Average	Vertical	9.5	37.9	-7.5	39.9	54.0	-14.1
4880.0	Peak	Horizontal	16.6	37.9	0.0	54.5	74.0	-19.5
4880.0	Average	Horizontal	12.7	37.9	-7.5	43.1	54.0	-10.9
7320.0	Peak	Vertical	12.6	42.3	0.0	54.9	74.0	-19.1
7320.0	Average	Vertical	2.4	42.3	-7.5	37.2	54.0	-16.8
7320.0	Peak	Horizontal	19.7	42.3	0.0	62.0	74.0	-12.0
7320.0	Average	Horizontal	9.2	42.3	-7.5	44.0	54.0	-10.0
9670.0	Peak	Vertical	4.1	44.8	0.0	48.9	74.0	-25.1
9670.0	Average	Vertical	-3.3	44.8	-7.5	34.0	54.0	-20.0
9670.0	Peak	Horizontal	8.1	44.8	0.0	52.9	74.0	-21.1
9670.0	Average	Horizontal	1.6	44.8	-7.5	38.9	54.0	-15.1
12200.0	Peak	Vertical	4.5	47.1	0.0	51.6	74.0	-22.4
12200.0	Average	Vertical	-2.8	47.1	-7.5	36.8	54.0	-17.2
12200.0	Peak	Horizontal	3.7	47.1	0.0	50.8	74.0	-23.2
12200.0	Average	Horizontal	-4.6	47.1	-7.5	35.0	54.0	-19.0
14640.0	Peak	Vertical	-0.8	50.5	0.0	49.7	74.0	-24.3
14640.0	Average	Vertical	-12.4	50.5	-7.5	30.6	54.0	-23.4
14640.0	Peak	Horizontal	-0.4	50.5	0.0	50.1	74.0	-23.9
14640.0	Average	Horizontal	-12.3	50.5	-7.5	30.7	54.0	-23.3

Transmitting at the Highest Frequency (2480 MHz)

Frequency (MHz)	Detection Mode	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Averaging Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
4960.0	Peak	Vertical	13.5	38.0	0.0	51.5	74.0	-22.5
4960.0	Average	Vertical	10.0	38.0	-7.5	40.5	54.0	-13.5
4960.0	Peak	Horizontal	17.6	38.0	0.0	55.6	74.0	-18.4
4960.0	Average	Horizontal	15.3	38.0	-7.5	45.8	54.0	-8.2
7440.0	Peak	Vertical	2.4	42.7	0.0	45.1	74.0	-28.9
7440.0	Average	Vertical	-10.7	42.7	-7.5	24.5	54.0	-29.5
7440.0	Peak	Horizontal	1.4	42.7	0.0	44.1	74.0	-29.9
7440.0	Average	Horizontal	-9.0	42.7	-7.5	26.2	54.0	-27.8
9920.0	Peak	Vertical	0.4	44.9	0.0	45.3	74.0	-28.7
9920.0	Average	Vertical	-11.3	44.9	-7.5	26.1	54.0	-27.9
9920.0	Peak	Horizontal	0.2	44.9	0.0	45.1	74.0	-28.9
9920.0	Average	Horizontal	-9.5	44.9	-7.5	27.9	54.0	-26.1
12400.0	Peak	Vertical	-0.3	46.9	0.0	46.6	74.0	-27.4
12400.0	Average	Vertical	-12.5	46.9	-7.5	26.9	54.0	-27.1
12400.0	Peak	Horizontal	0.1	46.9	0.0	47.0	74.0	-27.0
12400.0	Average	Horizontal	-12.5	46.9	-7.5	26.9	54.0	-27.1
14880.0	Peak	Vertical	-1.3	49.8	0.0	48.5	74.0	-25.5
14880.0	Average	Vertical	-13.2	49.8	-7.5	29.1	54.0	-24.9
14880.0	Peak	Horizontal	-1.2	49.8	0.0	48.6	74.0	-25.4
14880.0	Average	Horizontal	-13.5	49.8	-7.5	28.8	54.0	-25.2

No other emissions were seen above the noise floor. Noise floor was greater than 6 dB below the limit. At frequencies above 15.0 GHz, a 1 meter measurement distance was used.

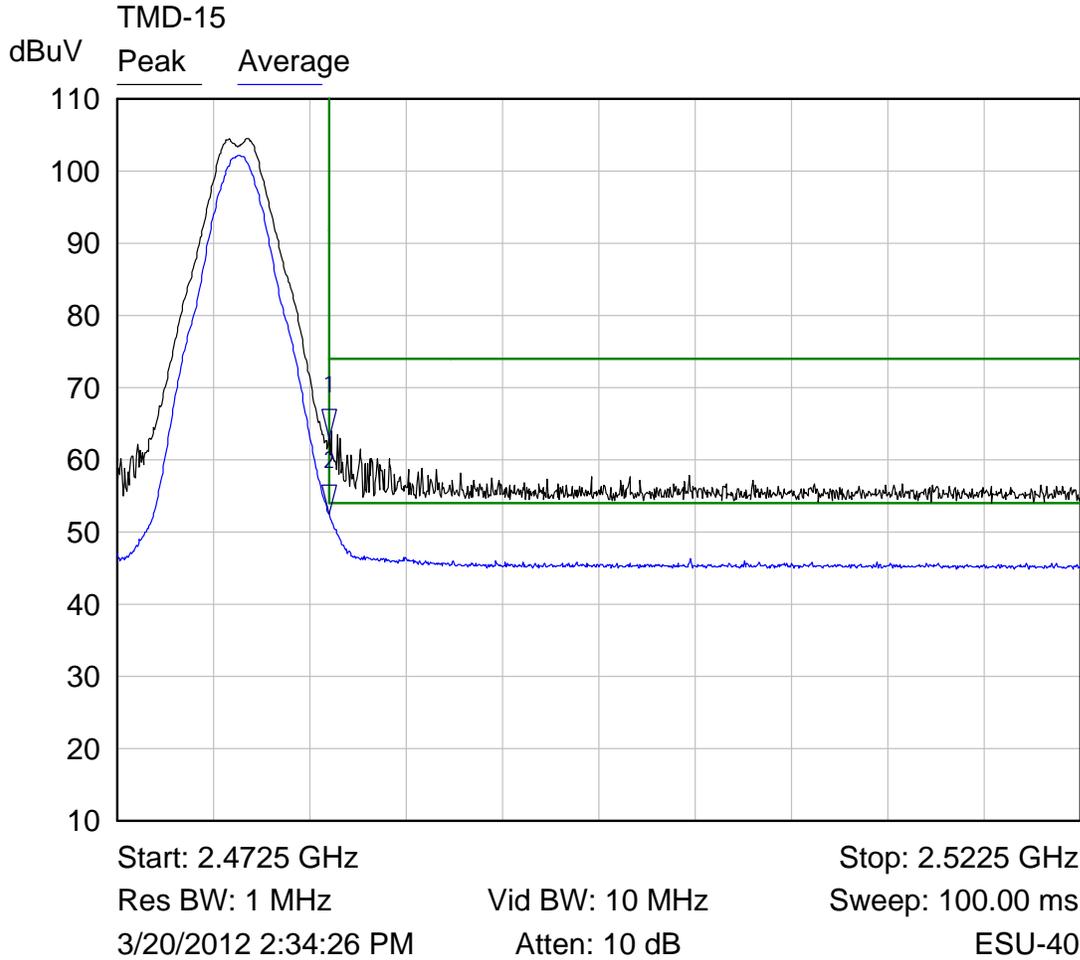
Lower Band Edge Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Peak	2.4023 GHz	101.62 dBuV	
2-1 ▽	Peak	-2.3000 MHz	-22.26 dB	
3 ▽	Average	2.4028 GHz	92.72 dBuV	
4-3 ▽	Average	-2.8000 MHz	-27.26 dB	

Power level 255 - Limit lines show restricted bands limits, markers show emission within the operating band of 2400 MHz to 2483.5 MHz by being greater than 20 dB down at 2.4 GHz

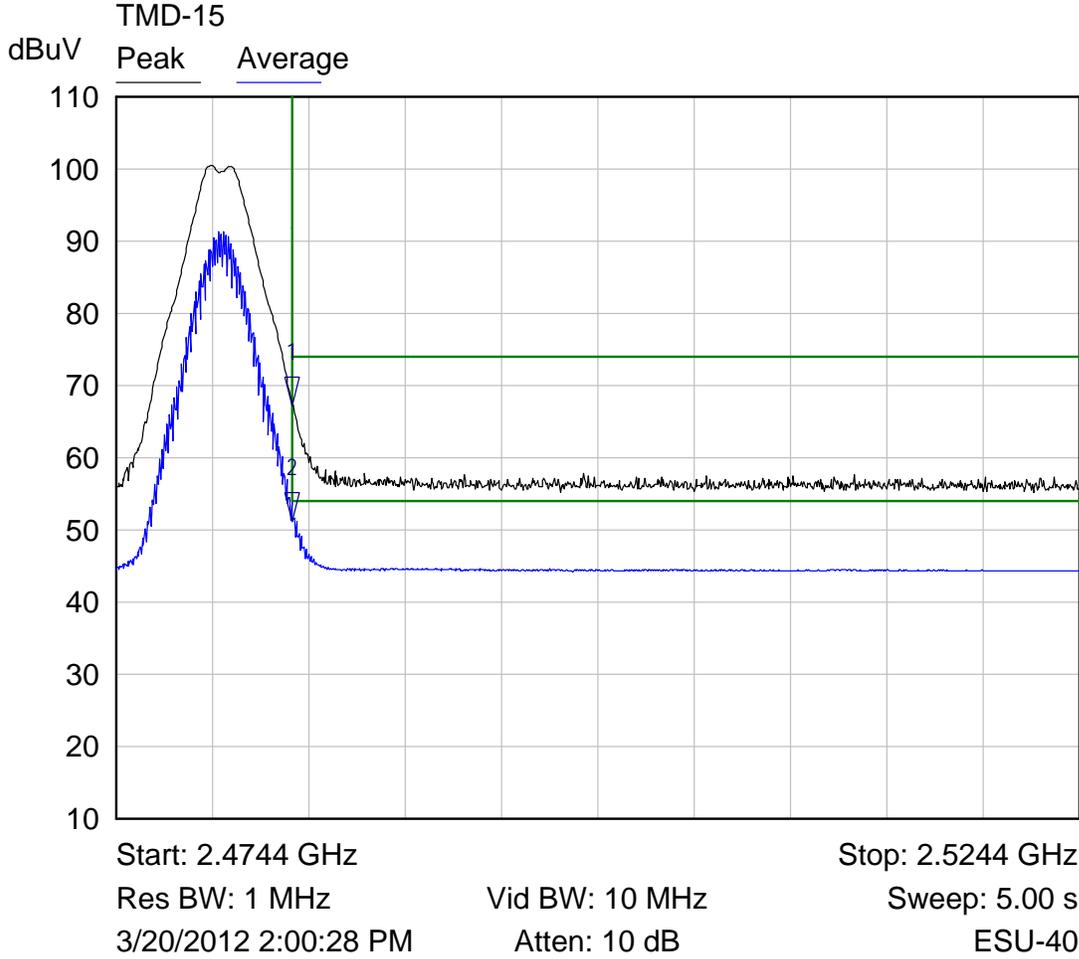
Band Edge Plot Operating at 2479 MHz with Power at 255 Setting



Mkr	Trace	X-Axis	Value	Notes
1 ▾	Peak	2.4835 GHz	62.99 dBuV	
2 ▾	Average	2.4835 GHz	52.51 dBuV	

Power level 255

Upper Channel Band Edge Plot – 2480 MHz at 205 Power Setting



Mkr	Trace	X-Axis	Value	Notes
1 ▾	Peak	2.4835 GHz	67.17 dBuV	
2 ▾	Average	2.4835 GHz	51.11 dBuV	

6.2.6 §15.247(d) Peak Power Spectral Density

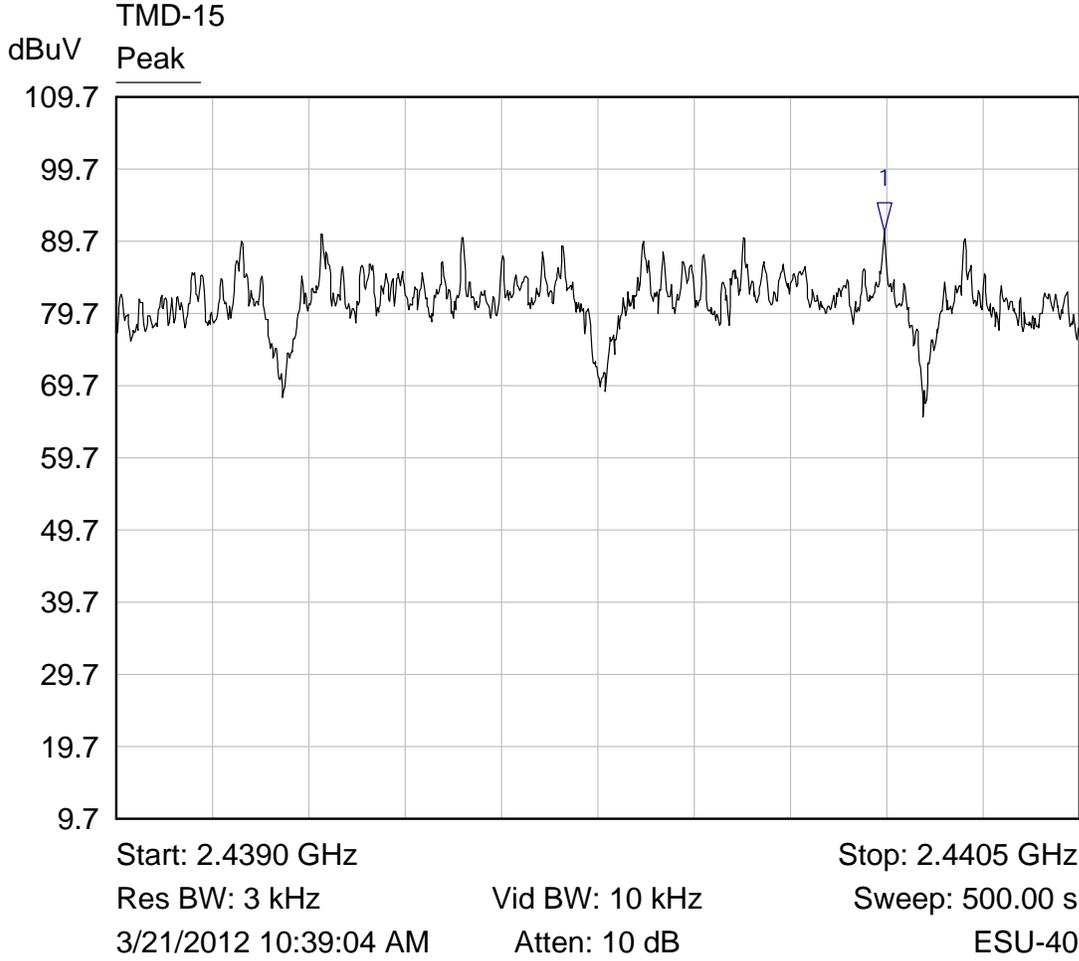
The EUT uses a trace antenna on the PCB that has a maximum gain of 3.3 dBi, or a numeric gain of 2.14. The peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. The maximum field strength was measured at a distance of 3 meters. Then the field strength was converted to Peak Conducted Power Spectral Density. That value was compared to the limit of 8 dBm. The plots are shown below and the results of this testing are summarized in the table below.

Frequency (MHz)	Measurement (dB μ V/m)	Calculated Power Spectral Density (dBm)
2403	92.65	-5.88
2440	90.95	-7.70
2480	88.41	-10.13

RESULT

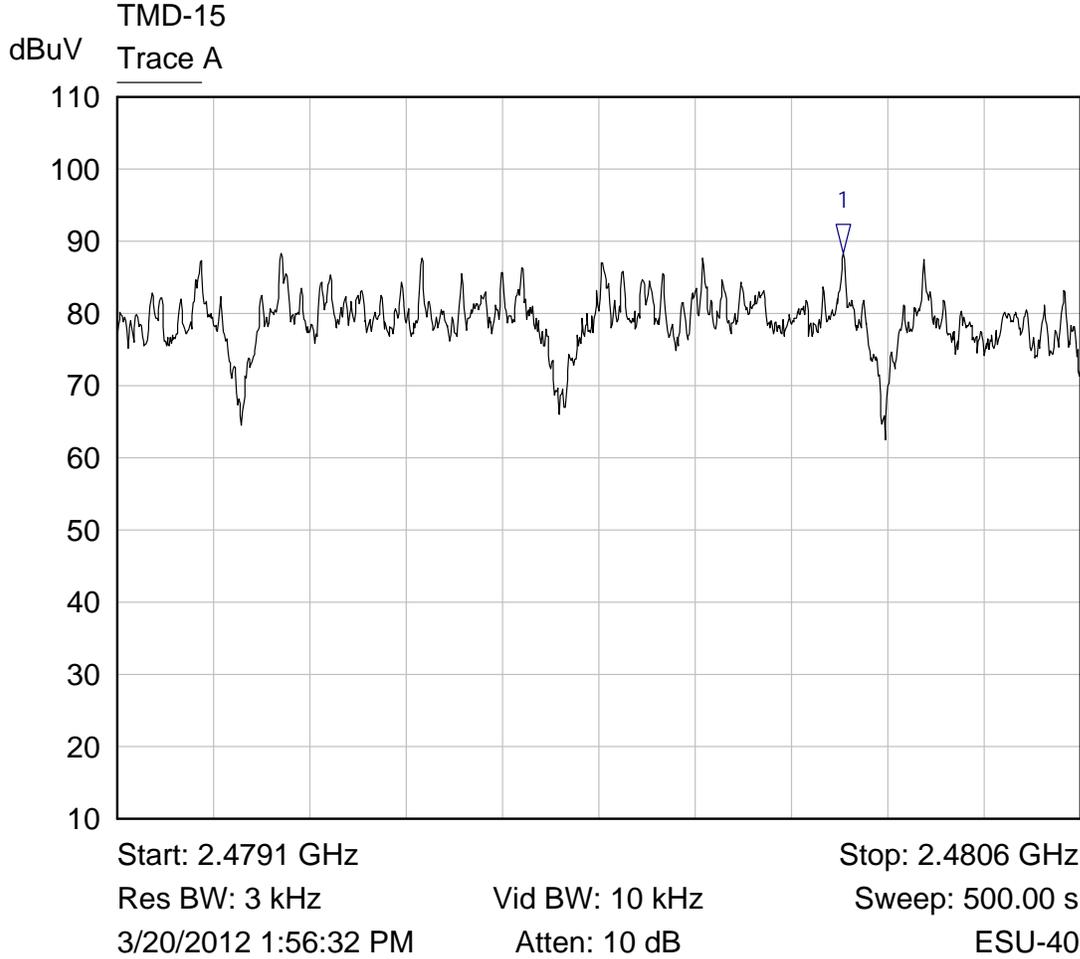
The maximum peak power spectral density was -5.88 dBm. The limit is 8 dBm. The EUT complies with the specification by 13.88 dB.

Middle Channel



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Peak	2.4402 GHz	90.95 dBuV	

Highest Channel



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4802 GHz	88.41 dBuV	

APPENDIX 1 TEST PROCEDURES AND TEST EQUIPMENT**A1.1 §15.207 Conducted Disturbance at the AC Mains**

The conducted disturbance at mains ports from the EUT was measured using a spectrum analyzer with a quasi-peak adapter for peak, quasi-peak and average readings. The quasi-peak adapter uses a bandwidth of 9 kHz, with the spectrum analyzer's resolution bandwidth set at 100 kHz, for readings in the 150 kHz to 30 MHz frequency ranges.

The conducted disturbance at mains ports measurements are performed in a screen room using a (50 Ω /50 μ H) Line Impedance Stabilization Network (LISN).

Where mains flexible power cords are longer than 1 m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0.4 m in length.

Where the EUT is a collection of devices with each device having its own power cord, the point of connection for the LISN is determined from the following rules:

- (a) Each power cord, which is terminated in a mains supply plug, shall be tested separately.
- (b) Power cords, which are not specified by the manufacturer to be connected via a host unit, shall be tested separately.
- (c) Power cords which are specified by the manufacturer to be connected via a host unit or other power supplying equipment shall be connected to that host unit and the power cords of that host unit connected to the LISN and tested.
- (d) Where a special connection is specified, the necessary hardware to effect the connection is supplied by the manufacturer for the testing purpose.
- (e) When testing equipment with multiple mains cords, those cords not under test are connected to an artificial mains network (AMN) different than the AMN used for the mains cord under test.

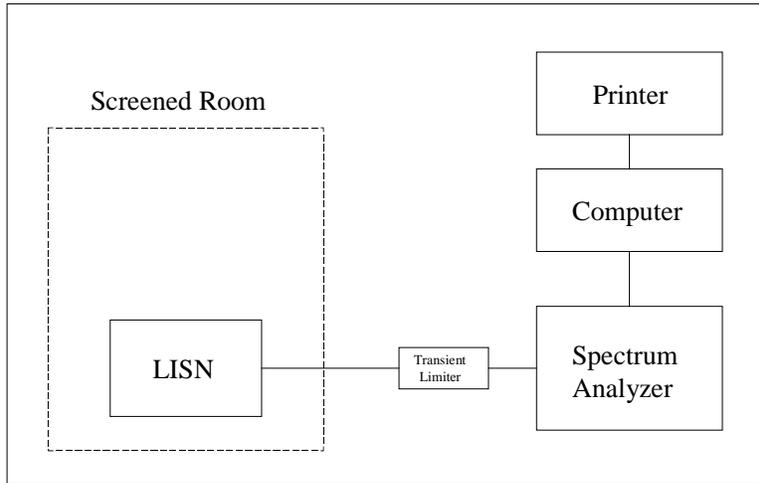
For AC mains port testing, desktop EUT are placed on a non-conducting table at least 0.8 meters from the metallic floor and placed 40 cm from the vertical coupling plane (copper plating in the wall behind EUT table). Floor standing equipment is placed directly on the earth grounded floor.

Type of Equipment	Manufacturer	Model Number	Serial Number	Date of Last Calibration
Wanship Open Area Test Site #2	Nemko-CCL, Inc.	N/A	N/A	11/16/2011
Test Software	Nemko-CCL, Inc.	Conducted Emissions	Revision 1.2	N/A
Spectrum Analyzer	Hewlett Packard	8566B	2230A01711	01/17/2012

Type of Equipment	Manufacturer	Model Number	Serial Number	Date of Last Calibration
Quasi-Peak Detector	Hewlett Packard	85650A	2043A00137	01/18/2012
LISN	EMCO	3825/2	9305-2099	03/12/2012
Conductance Cable Wanship Site #2	Nemko-CCL, Inc.	Cable J	N/A	12/14/2011
Transient Limiter	Hewlett Packard	11947A	3107A02266	12/14/2011

An independent calibration laboratory or Nemko-CCL Inc. personnel calibrates all the equipment listed above at intervals defined in ANSI C63.4:2003 Section 4.4 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to tractability is on file and is available for examination upon request.

Conducted Emissions Test Setup



A1.2 §15.247 Radiated Measurements

The radiated disturbance from the EUT was measured using a spectrum analyzer with a quasi-peak adapter for peak and quasi-peak readings. A preamplifier with a fixed gain of 26 dB was used to increase the sensitivity of the measuring instrumentation. The quasi-peak adapter uses a bandwidth of 120 kHz, with the spectrum analyzer's resolution bandwidth set at 1 MHz, for readings in the 30 to 1000 MHz frequency ranges.

A biconilog antenna was used to measure the frequency range of 30 to 1000 MHz, at a distance of 3 meters from the EUT. The readings obtained by these antennas are correlated to the levels obtained with a tuned dipole antenna by adding antenna factors. A double-ridged guide antenna was used to measure the emissions at frequencies above 1000 MHz at a distance of 3 or 1 meter from the EUT.

The configuration of the EUT was varied to find the maximum radiated emission. The EUT was connected to the peripherals listed in Section 2.3 via the interconnecting cables listed in Section 2.4. A technician manually manipulated these interconnecting cables to obtain worst-case radiated disturbance. The EUT was rotated 360 degrees, and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission. Where there were multiple interface ports all of the same type, cables are either placed on all of the ports or cables added to these ports until the emissions do not increase by more than 2 dB.

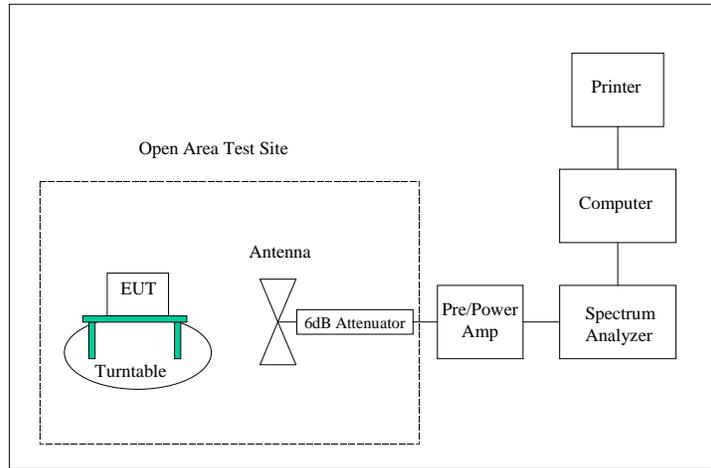
Desktop EUT are measured on a non-conducting table 0.8 meters above the ground plane. The table is placed on a turntable, which is level with the ground plane. For equipment normally placed on floors, the equipment shall be placed directly on the turntable.

Type of Equipment	Manufacturer	Model Number	Serial Number	Date of Last Calibration
Wanship Open Area Test Site #2	Nemko-CCL, Inc.	N/A	N/A	11/16/2011
Test Software	Nemko-CCL, Inc.	Radiated Emissions	Revision 1.3	N/A
Spectrum Analyzer/Receiver	Rhode & Schwarz	1302.6005.40	100064	07/28/2011
Spectrum Analyzer	Hewlett Packard	8566B	2230A01711	01/17/2012
Quasi-Peak Detector	Hewlett Packard	85650A	2043A00137	01/18/2012
Biconilog Antenna	EMCO	3142	9601-1009	05/21/2011
Double Ridged Guide Antenna	EMCO	3115	9604-4779	03/10/2011
High Frequency Amplifier	Miteq	AFS4-01001800-43-10P-4	1096455	06/22/2011

Type of Equipment	Manufacturer	Model Number	Serial Number	Date of Last Calibration
20' High Frequency Cable	Microcoax	UFB197C-1-3120-000000	1297	05/10/2011
3 Meter Radiated Emissions Cable Wanship Site #2	Microcoax	UFB205A-0-4700-000000	1295	05/10/2011
Pre/Power-Amplifier	Hewlett Packard	8447F	3113A05161	08/25/2011
6 dB Attenuator	Hewlett Packard	8491A	32835	12/14/2011

An independent calibration laboratory or Nemko-CCL, Inc. personnel calibrates all the equipment listed above at intervals defined in ANSI C63.4:2003 Section 4.4 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to tractability is on file and is available for examination upon request.

Radiated Emissions Test Setup

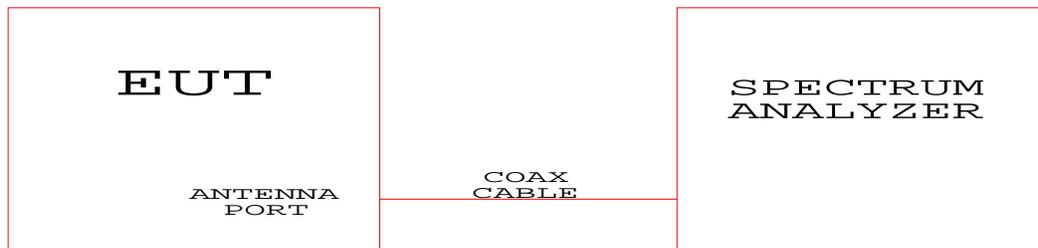


A1.2 §15.247 Conducted Measurements at the Antenna

Type of Equipment	Manufacturer	Model Number	Serial Number
Spectrum Analyzer	Hewlett Packard	8566B	2230A01711
Quasi-Peak Detector	Hewlett Packard	85650A	2043A00137
Spectrum Analyzer/Receiver	Rohde & Schwarz	1302.6005.40	100064
Low Loss Cable (1 dB)	N/A	N/A	N/A

An independent calibration laboratory or Nemko-CCL, Inc. personnel calibrates all the equipment listed above at intervals defined in ANSI C63.4:2003 Section 4.4 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to tractability is on file and is available for examination upon request.

Test Configuration Block Diagram

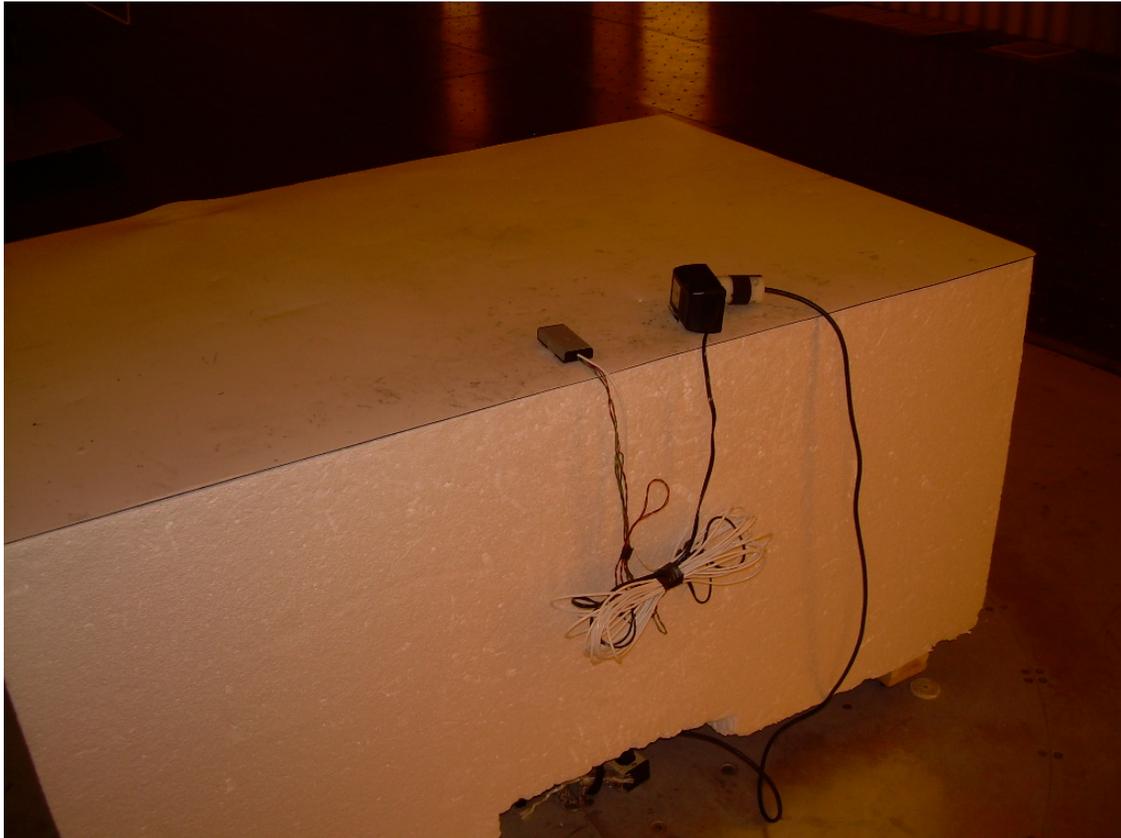


APPENDIX 2 PHOTOGRAPHS

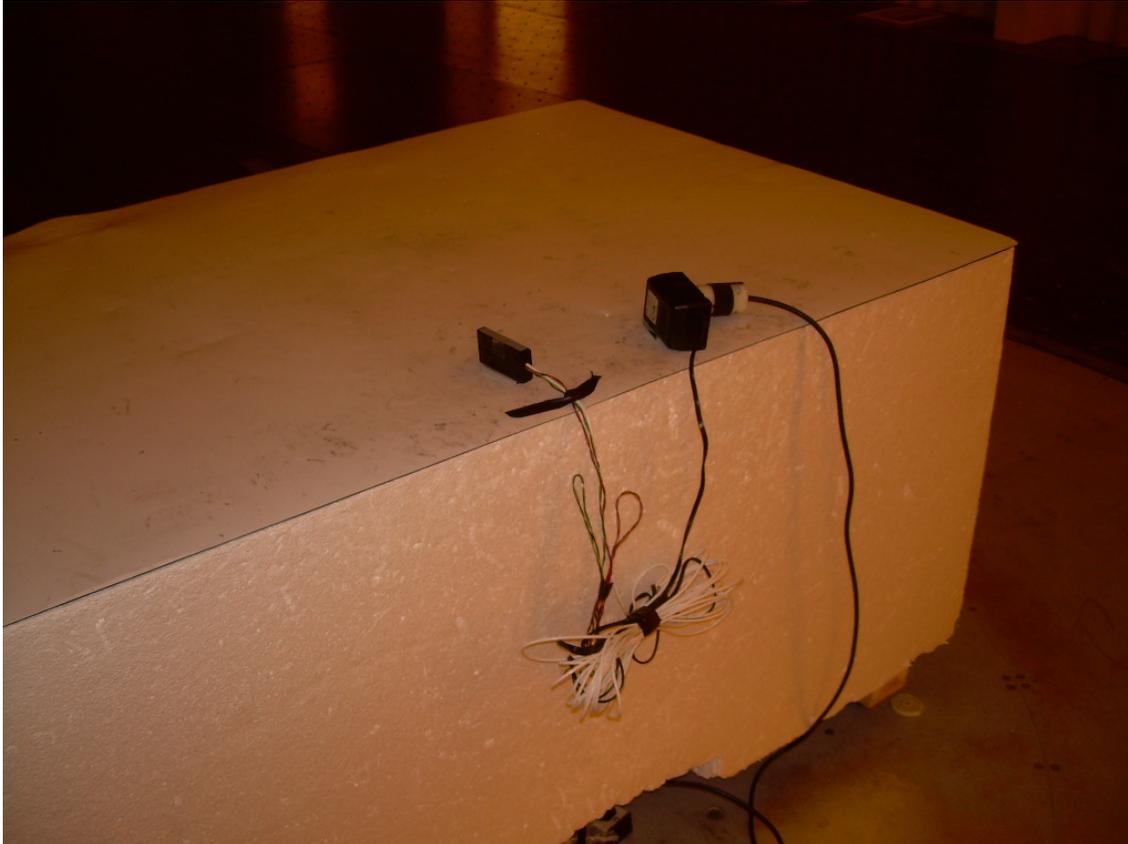
Photograph 1 – Front View Radiated Emission Worst Case Configuration



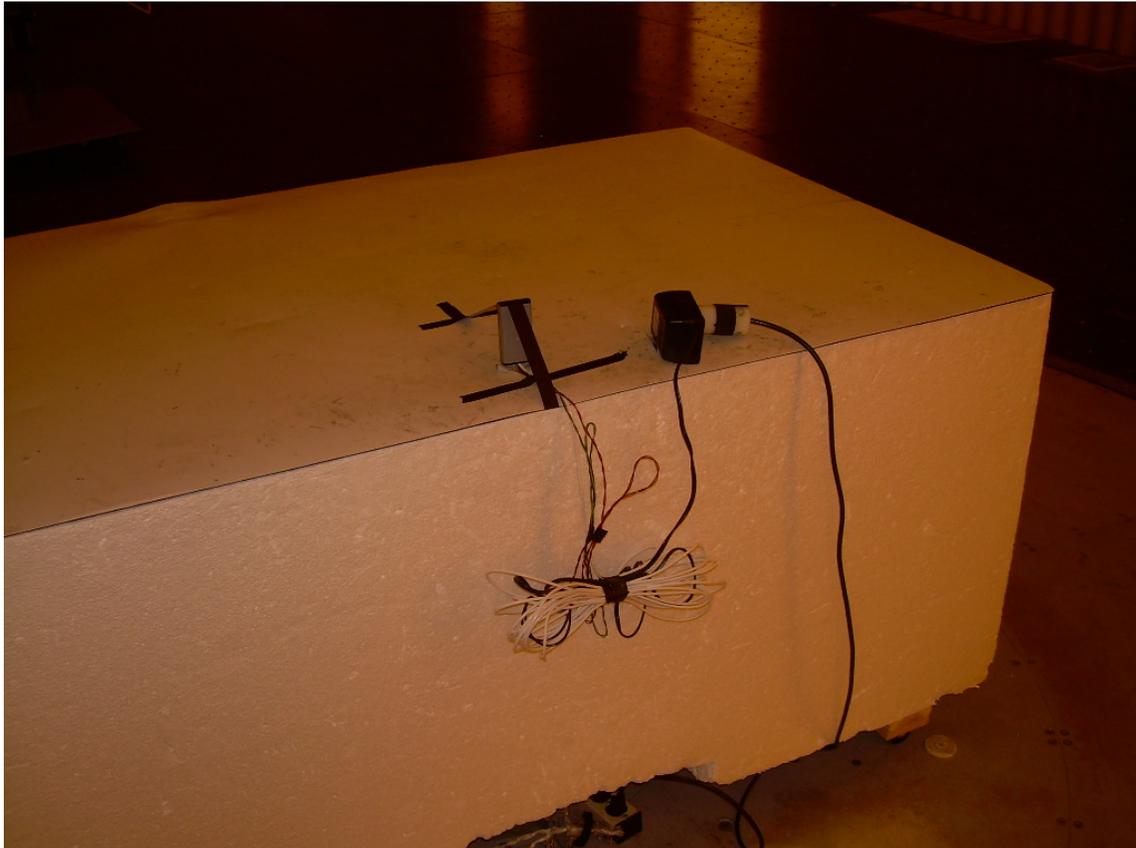
Photograph 2 – Back View Radiated Emission Worst Case Configuration



Photograph 3 – On Edge Radiated Emission Configuration



Photograph 4 – Vertical Radiated Emission Configuration



Photograph 5 – View of the Radiated Emission Configuration Using Battery Power



Photograph 6 – Front View Conducted Emission Worst Case Configuration



Photograph 7 – Back View Conducted Emission Worst Case Configuration



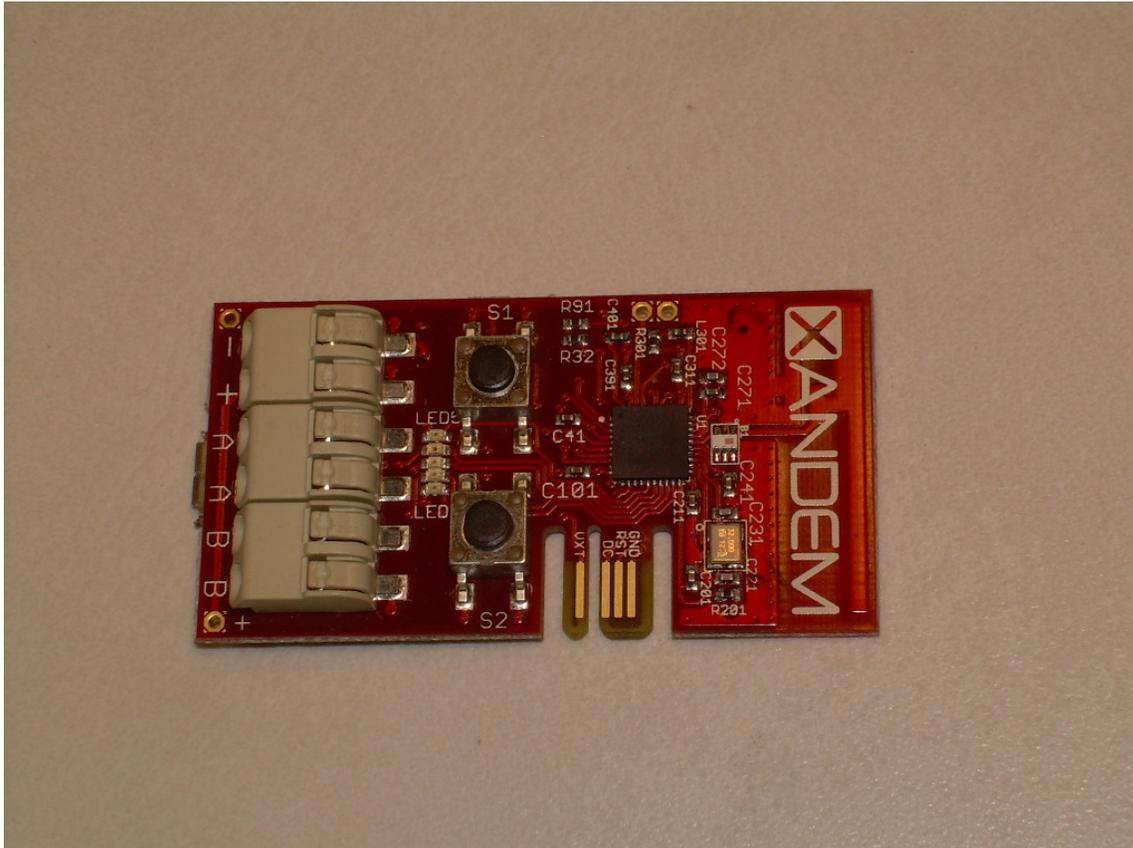
Photograph 8 – Front View of the EUT



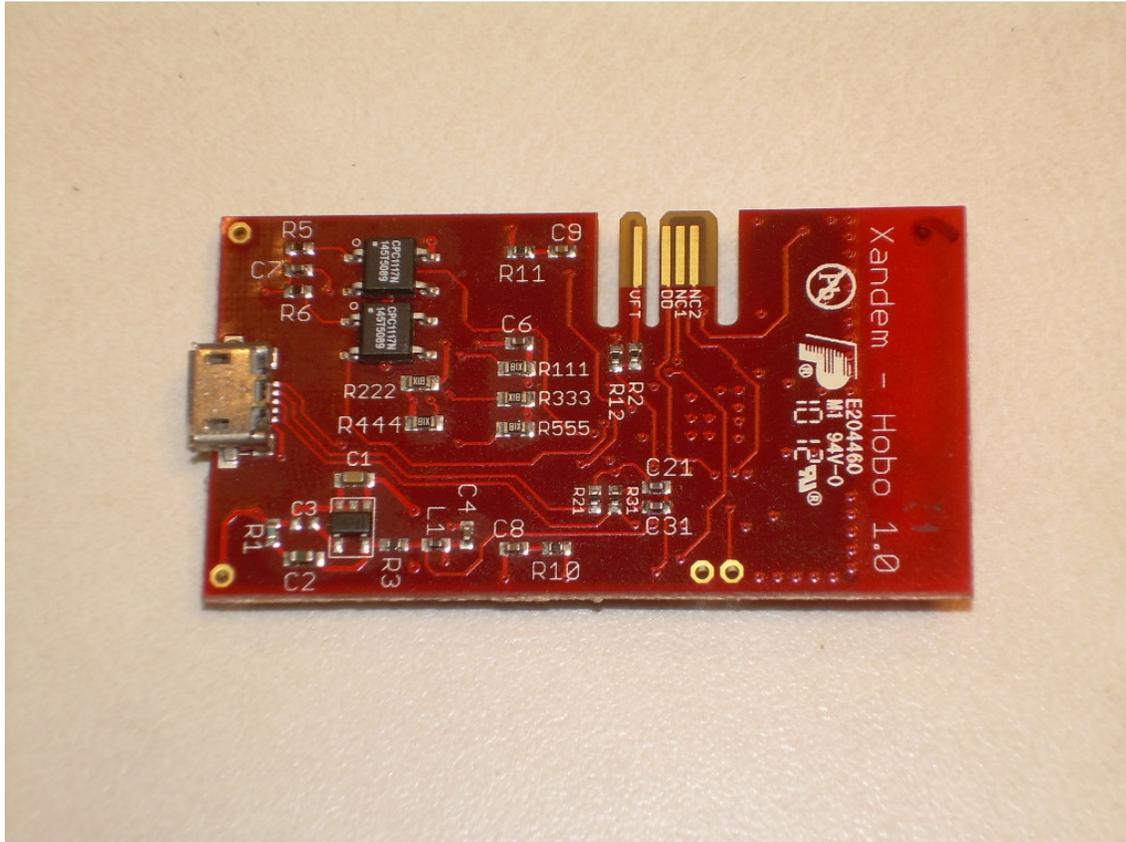
Photograph 9 – Back View of the EUT



Photograph 10 – View of the Component Side of the PCB



Photograph 11 – View of the Trace Side of the PCB



APPENDIX 3 MANUFACTURER'S STATEMENT/ATTESTATION

The manufacturer or responsible party for the equipment tested hereby affirms:

- a) That he/she has reviewed and concurs that the tests shown in this report are reflective of the operational characteristics of the device for which certification is sought;
- b) That the device in this test report will be representative of production units;
- c) That the product will have all of the documented modifications incorporated into the product when manufactured and placed on the market;
- d) That all changes in hardware and software/firmware to the subject device will be reviewed.
- e) That any changes impacting the attributes, functionality or operational characteristics documented in this report will be communicated to the body responsible for approving or certifying the subject equipment.

Joey Wilson
Printed name of official


Signature of official

4/17/2012
Date

NOTE—This affirmation must be signed by the responsible party before it is submitted to a regulatory body for approval.